THE WHAT'S NEW MAGAZINE

Popular Science

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Tech Update on FLAT TV

PAGE 68

TOP SECRET

Invisible Aircraft

Daytime Stealth for Future Fighters

BULLETIN

FIRST DNA CLONE

How They Did It

Unlocking the Mysteries of JUPITER'S MOON

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This Month: Top Tools and Home Technologies

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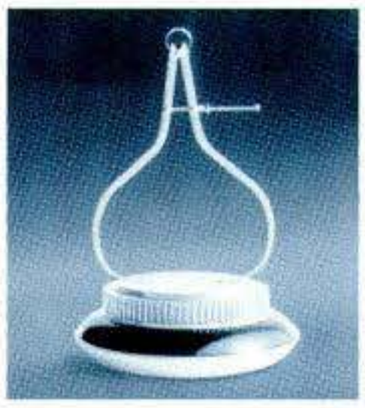

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05 PS 97

A TIMES MIRROR MAGAZINE

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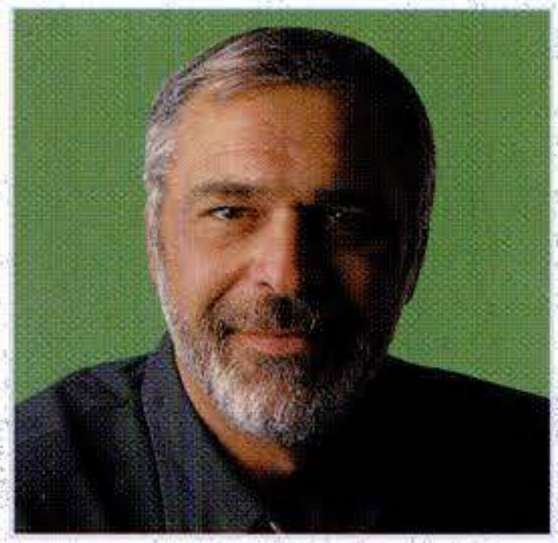

Saving Lives, and Copying Life

SUDDENLY, IN A WORLD FRENZIED by statistics, the tide of opinion has turned against automotive airbags. What is lost in the recent "death by airbag" headlines, however, is the well-documented fact that, properly used, airbags have saved hundreds more lives than they have harmed. Getting beyond the numbers, Automotive Editor Dan McCosh looks closely at how airbags work when the forces of a crash are unleashed. With better education and improvements in the technology, airbags can easily save twice as many lives. This is no time to be overregulating or over-litigating a genuine advance in automotive safety.

Speaking of headlines, "Hello Dolly" may turn out to be the science headline of the year—perhaps the decade. Dolly, of course, is the cloned sheep from Scotland. This story is still developing, as everyone from the pope to the president grapples with its ramifications. Contributing Editor Mark Uehling provides a short course on how researchers turned science fiction to fact.—*Fred Abatemarco,* **abatemarco@popsci.com**

Memories of P.S.

THE IMAGE OF the January 1929 cover really hit me as familiar when I saw 125 Years of POPULAR SCIENCE [Feb.]. In my attic, I found a compendium of 1929 stories assembled by my dad years ago. On top was the slightly torn January 1929 cover he chose to bind the other stories with, including the article on the Wright brothers. Reading those POPULAR SCIENCE stories from the late '20s through the '50s had sparked my interest in science as a youngster—and led to my career as a mechanical engineer. Now I am the subscriber to POPULAR SCIENCE, and I share my new issues with my 84-year-old father. Thanks for the memories.

Jim Stana
Orlando, Fla.

Dog Sounds

THE HYPERSONIC SOUND speakers mentioned in "Sound sans Speakers" [Electronics Newsfront, Feb.] appear to be an incredible advance. But because they use ultrasound waves, one question remains: Will my dog go crazy?

Tony Vorell
tonyvorell@juno.com

Don't worry: Your dog will be fine. The central operating range of the HSS speakers is 200,000 Hertz and above, and the hearing range of dogs is 120 to 100,000 Hertz.

Adjusting for Airbags

"SOFTER AIRBAGS Coming" [Automotive Newsfront, Feb.] says that adults sitting too close to airbags have suffered fatal injuries. But I found a possible solution in the same issue in "Women in Cockpits" [Science & Technology Newsfront]. A diagram with this article shows how the cockpit will be modified to accommodate pilots with various body types. One modification, for shorter pilots, is an adjustable foot pedal. The automotive industry could accommodate shorter drivers in a similar way.

Roger Mindel
Silver Spring, Md.

Cable Complaints

"CABLE TV STRIKES Back" [Feb.]? More like "Cable Strikes Out!" So the cable television industry took the basic satellite box and made a few changes to once again lock consumers to the wires. Big deal! If, like me, you have been frustrated more by the monopoly a cable company has on your business than the poor service, then the last thing you want to do is buy a new cable box.

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IF DES MOINES is any evidence, then cable's "digital counteroffensive" is a seriously telegraphed punch, at best. Here, TCI has stopped work on expanding the available channels above a piddly thirtysomething, it replaced popular channels with others that it owns, and it has reduced cable access for the local university. I'd buy a satellite dish in a heartbeat if I didn't live in a condominium that doesn't allow it.

James Jones
Clive, Iowa

Snooping Around

FAR FROM BEING about "Snoops" [Jan.], your article explains the meaning of "information age." What's on the Internet are, for the most part, public records available to any person who calls, writes, or travels to a government agency. Using your computer simply means that one no longer has to call, write, or travel. Does that make a person a snoop? I hardly think so.

Frank Thomas
intell@coqui.net

What Time Is It?

IN YOUR ANSWER regarding documents signed at midnight [FYI, Feb.], you say that a day begins at 0000 and ends at 2400. This isn't true. A digital clock goes from 23:59.59 to 00:00.00. The time 2400 never appears on a clock.

Craig Lawrence
craigcsl@aol.com

You are right in stating that clocks do not display 2400 as a time. It is also correct, however, to say that a document signed exactly at midnight could be dated 2400 October 21 or 0000 October 22.

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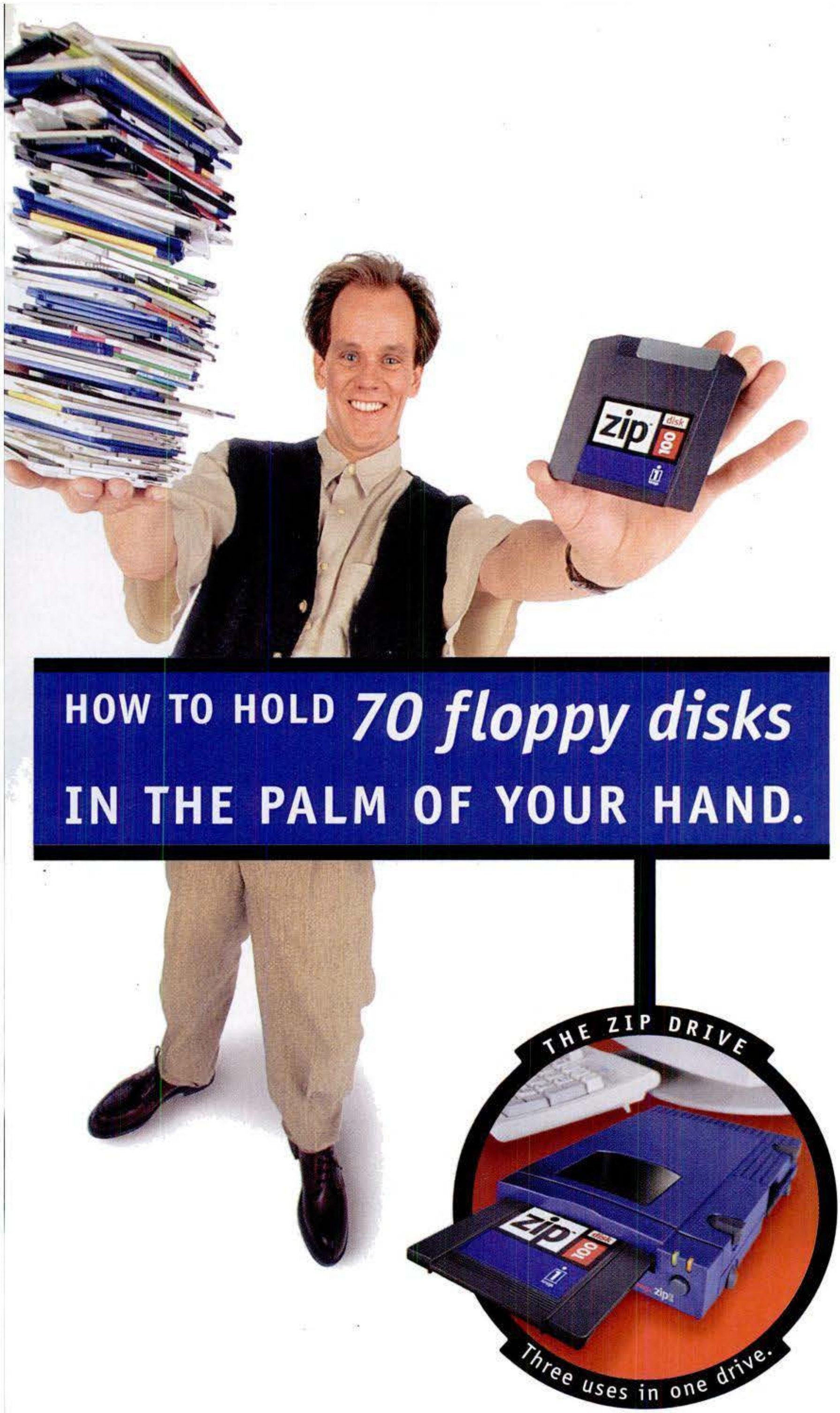

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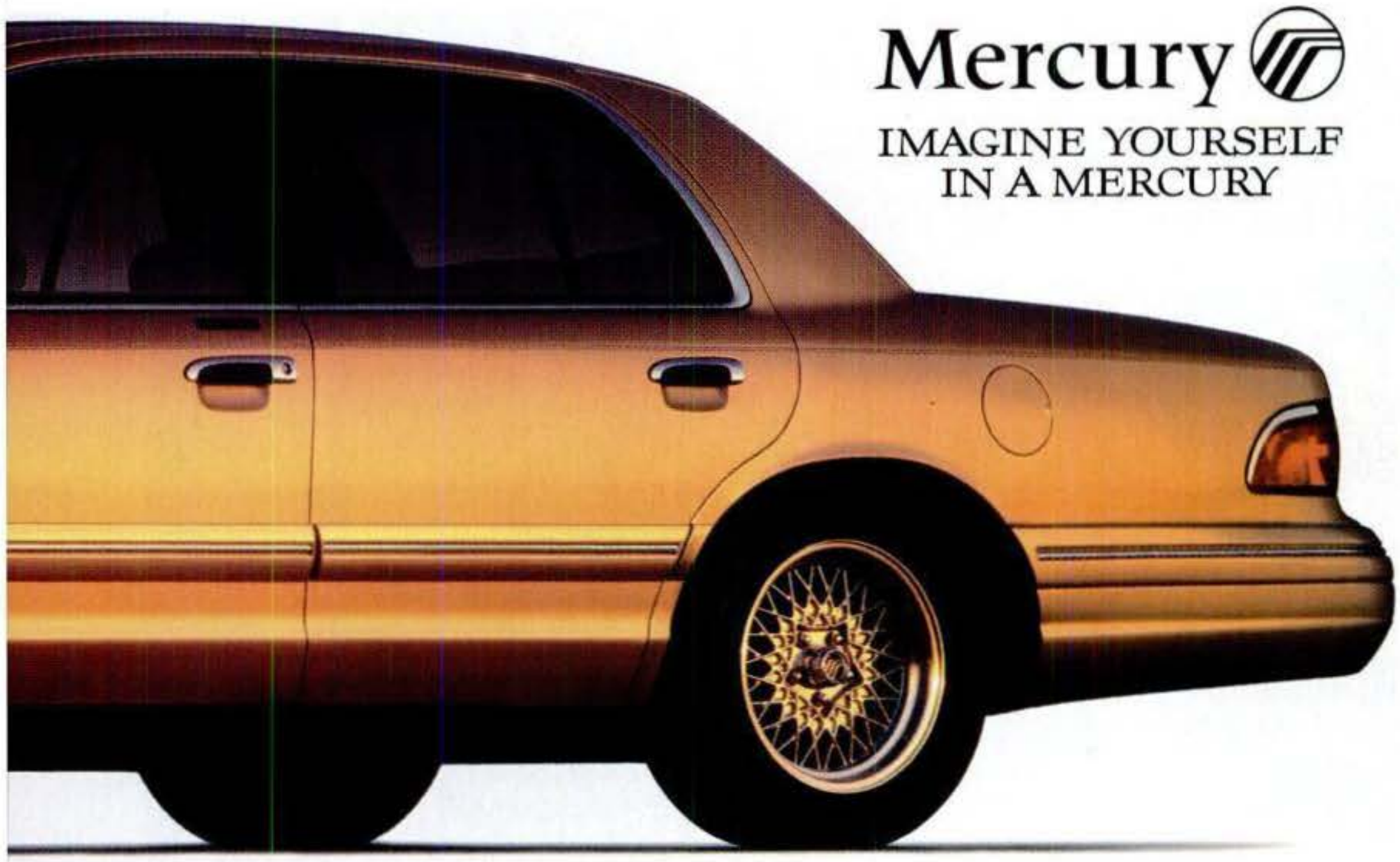

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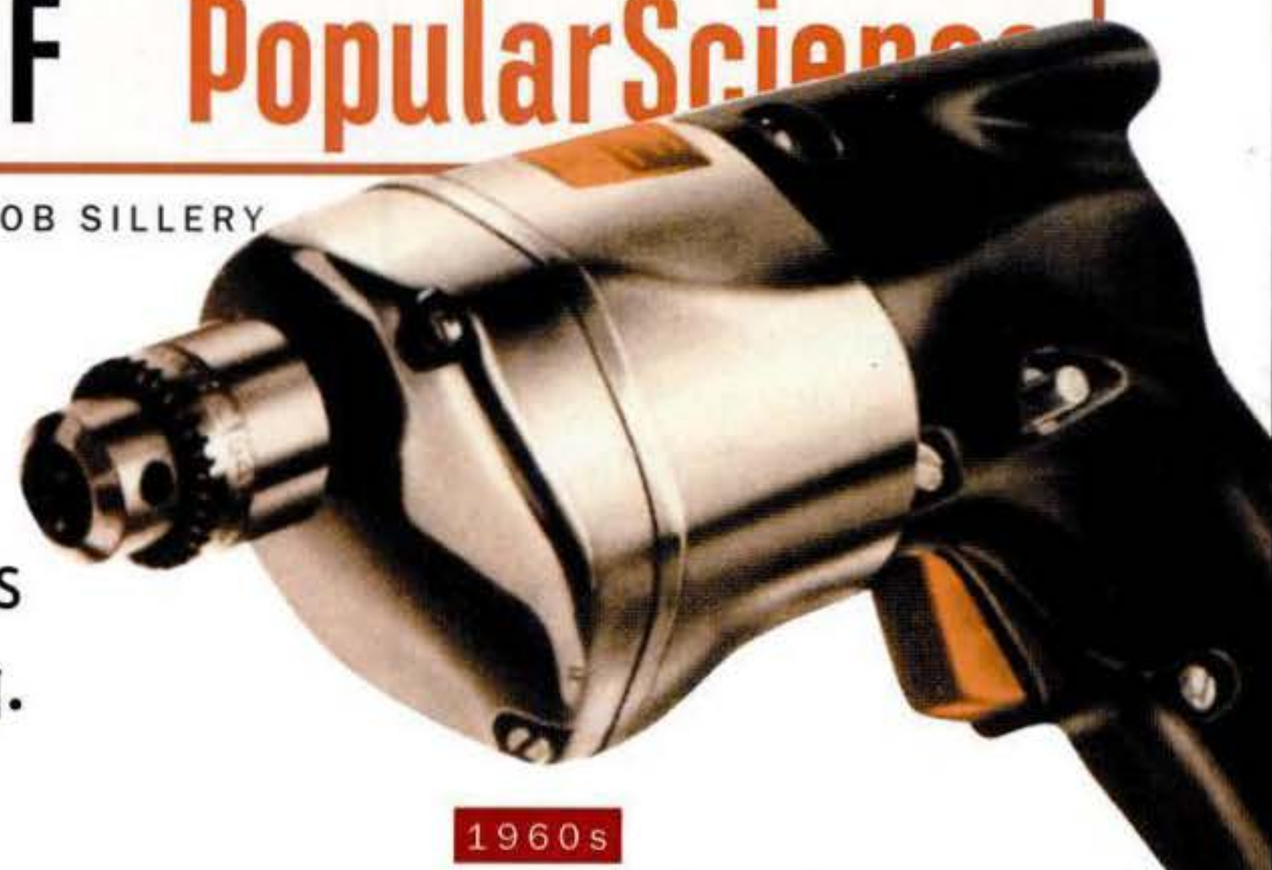


1960s

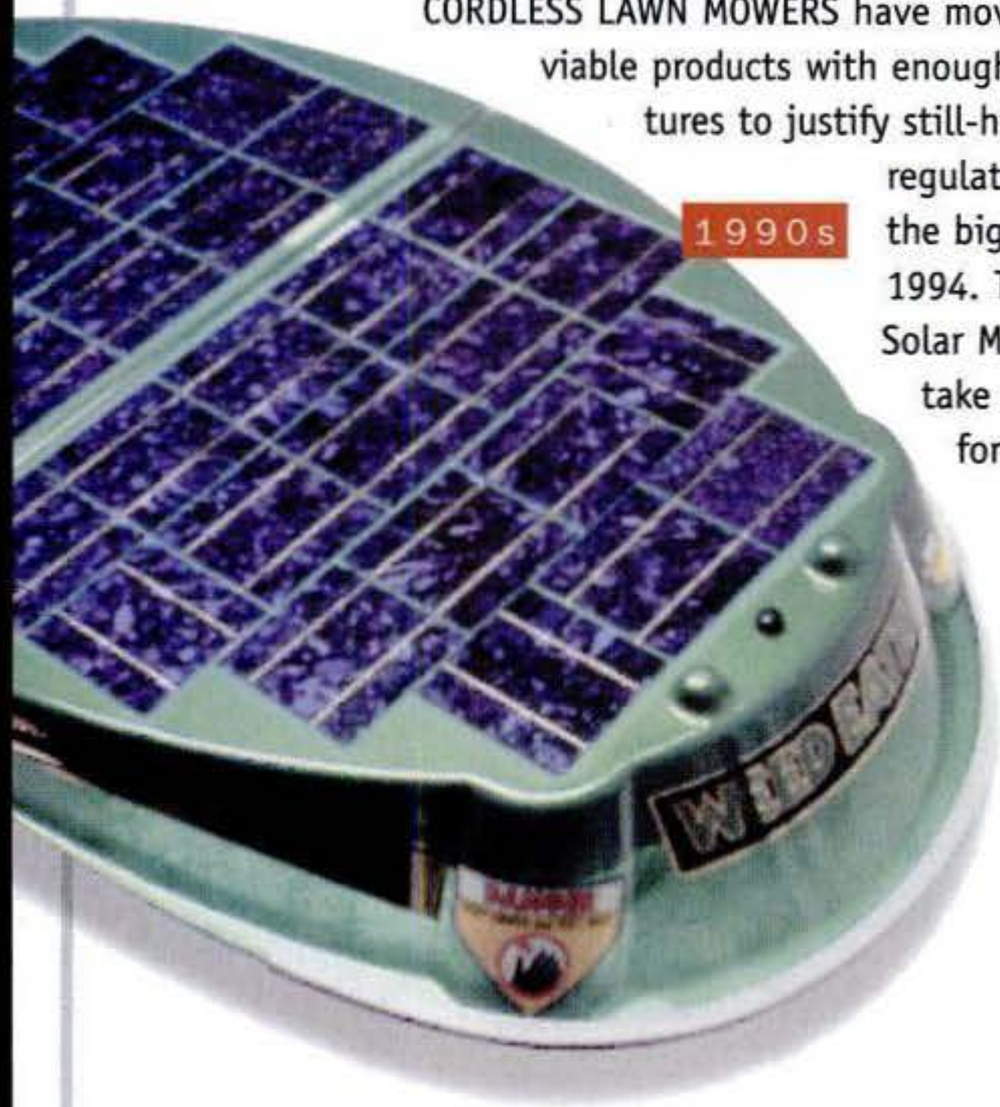
Drilling on a Charge

CORDLESS CONVENIENCE has now been with us for four decades, but was a marvel when POPULAR SCIENCE covered Black & Decker's nickel-cadmium-powered drill. The charger gave a power boost in five hours, or recharged fully overnight—while some of today's tool batteries recharge in minutes.

Cordless Cutters

CORDLESS LAWN MOWERS have moved from novelties to viable products with enough battery power and features to justify still-high prices. Environmental regulations gave these mowers the biggest push, we wrote in 1994. The Weed Eater Robotic Solar Mower (left) now lets us take a "mow-my-lawn-for-me" attitude.

1990s



Geodesic Dome

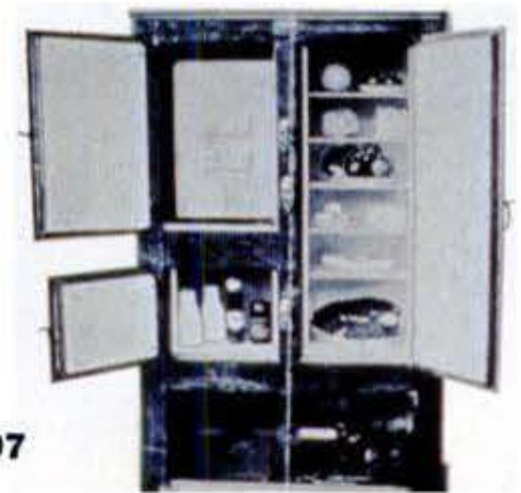
THOUGH THERE have been many alternative structures suggested for homes over the years, few fire the imagination as Buckminster Fuller's domes. In 1966, we cover a "sun dome," which keeps temperatures 20 to 30 degrees warmer indoors than outdoors. The domes are also extraordinarily strong.

1947

1915

Beyond the Icebox

THE GUARDIAN, the first self-contained home refrigerator and the predecessor of Frigidaire units, is developed in a backyard shop. "There is no scientific reason why a home refrigeration machine should not be a success," we state in 1916.



1902

The Big Chill

WILLIS H. CARRIER creates an air-conditioning system to control humidity in a lithography plant. POPULAR SCIENCE follows the technology through the early part of the century. As air conditioning becomes common in the 1950s, we ask, "Will Your Next House Have Central Cooling?"

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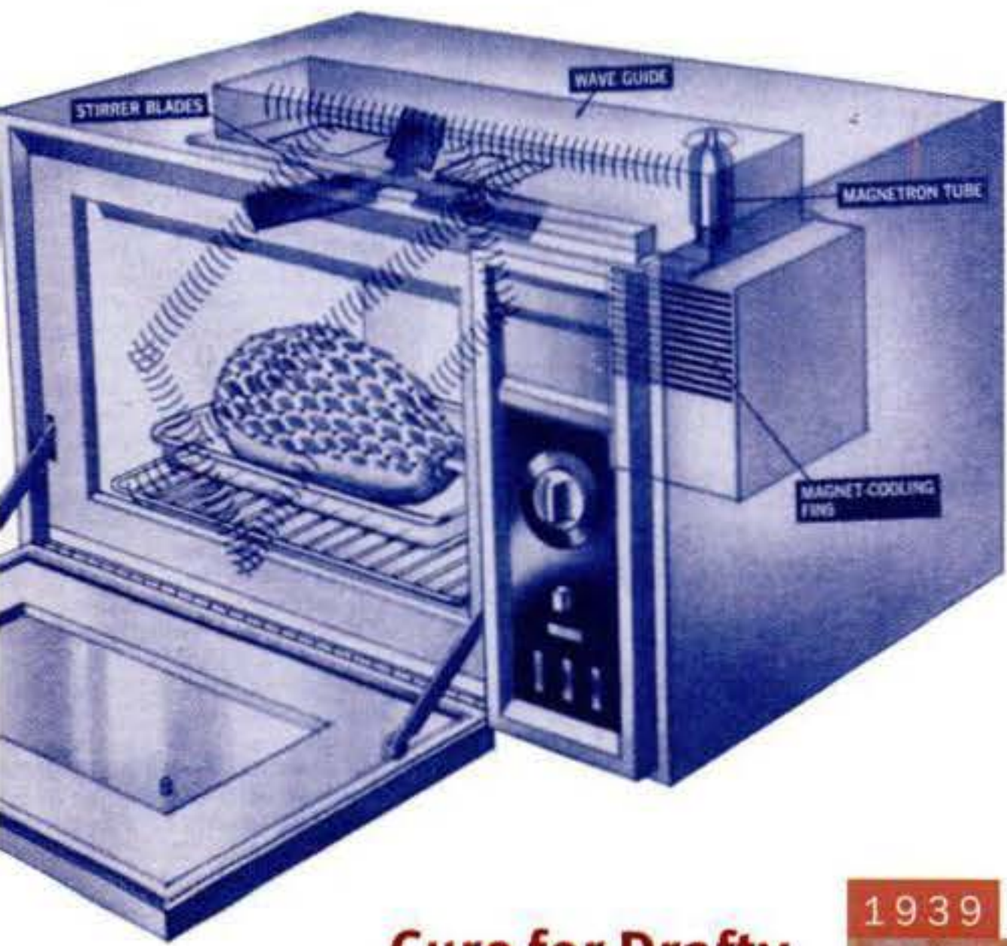
1947

Faster Food

THE FIRST microwave cooker, a bulky model called a radarange, is developed. The smaller models emerge in the 1970's; by 1973, the boom is on. In "The Facts About Microwave Ovens," POPULAR SCIENCE offers a guide to 36 products from 22 makers, and explains how magnetrons generate microwaves and cook food.



Cure for Drafty Houses

OWENS CORNING develops the binding that makes possible fiberglass batt insulation commonly installed in wall cavities. By 1953, enough home insulation options exist for POPULAR SCIENCE to detail "The Why, What, Where, and How of Home Insulation."

1939

Edison's Bright Idea

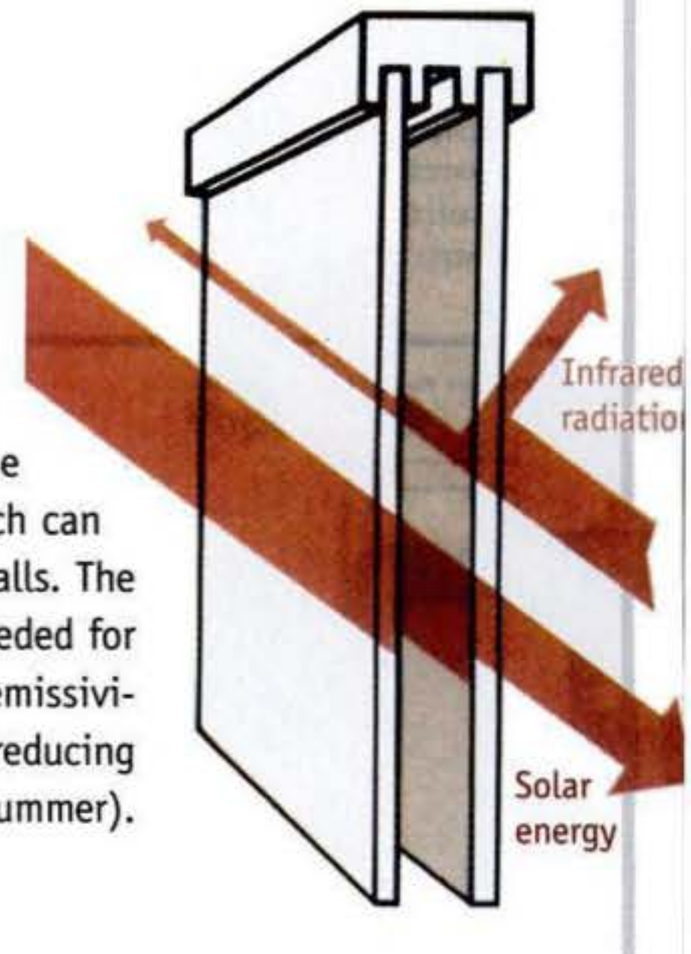
AFTER RELYING on flame for ages, indoor lighting meets the industrial age with the invention of Thomas Edison's light bulb. In February of 1880, we note a crucial step toward a modern bulb (left) when Edison uses current to heat a carbon filament to produce a "pleasant, moderate light."

1879

1980s

Superwindows

INSULATED WINDOWS take off with the introduction of "superwindows," which can sometimes be more efficient than walls. The windows reflect or retain heat as needed for energy efficiency. Here, an inner low-emissivity panel reflects infrared energy, thus reducing heat loss (and heat gain in summer).



Harnessing the Sun 1970s

WHILE OTHERS are satisfied with solar heating in the energy-aware '70s, POPULAR SCIENCE goes that one better: "With clever engineering," we note, "sun power can cool your house, too." Against the threat of global warming in the '80s, we see solar power "poised for a burst of energy."

Also Noted...

- 1880s Use of U-shaped water traps blocks deadly sewer gas.
- 1910s Electric drill and dishwasher invented.
- 1950s Chainsaw comes to consumers.
- 1980s Development of engineered lumber.
- 1980s Advent of the "smart," or automated, house.
- 1980s Energy-efficient "zoned" heating developed.
- 1990s Experimental microwave clothes dryer debuts.

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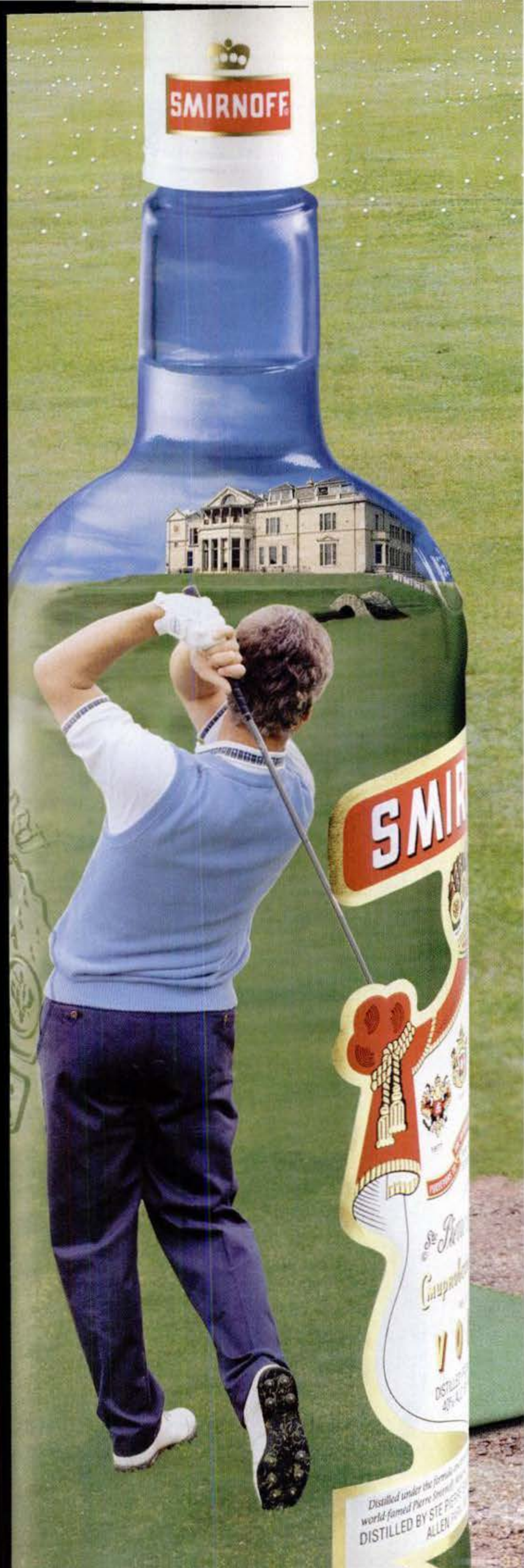

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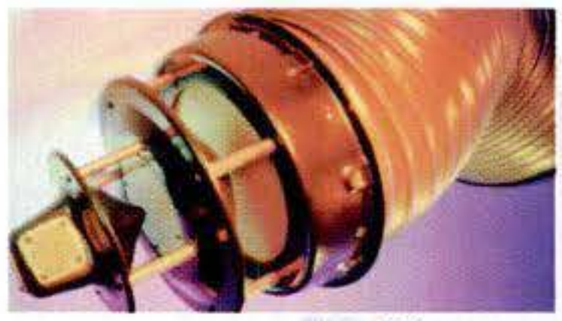
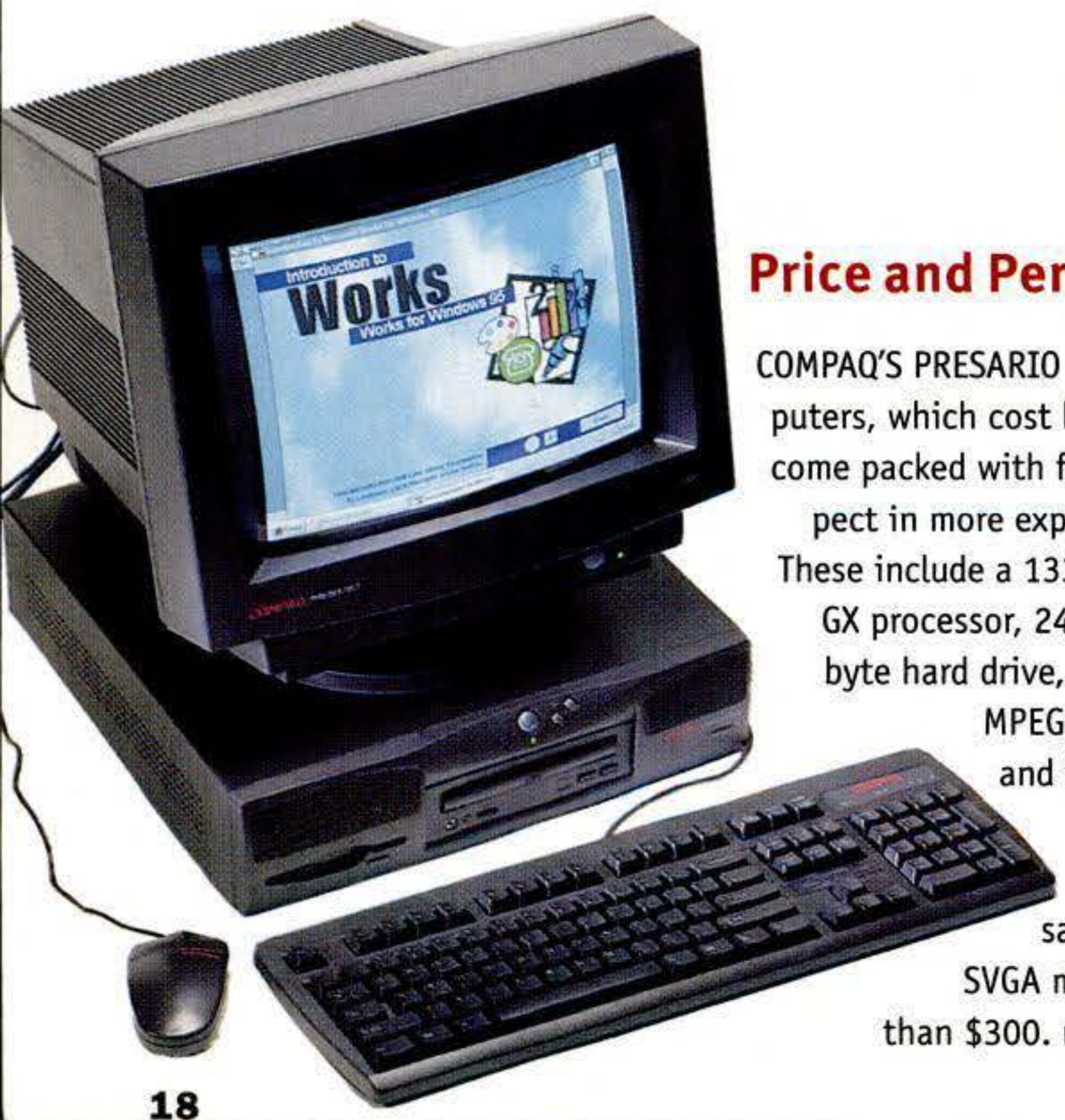
Tubular Sound



DESIGNED FOR enjoyment throughout a room, SoundTube stereo speakers disperse sound over 360 degrees, rather than aiming for the "sweet spot" targeted by traditional rectangular speakers. Prices start at $450. SoundTube Entertainment Inc., Box 1120, 505 Main St., Park City UT 84060.



Price and Performance

COMPAQ'S PRESARIO 2000 series computers, which cost less than $1,000, come packed with features you'd expect in more expensive machines. These include a 133MHz Cyrix Media GX processor, 24MB RAM, 2-gigabyte hard drive, 33.6bps modem, MPEG-1 video support, and integrated stereo speakers. The companion Presario V400 14-inch SVGA monitor costs less than $300. *www.compaq.com*

Meet the Beetle

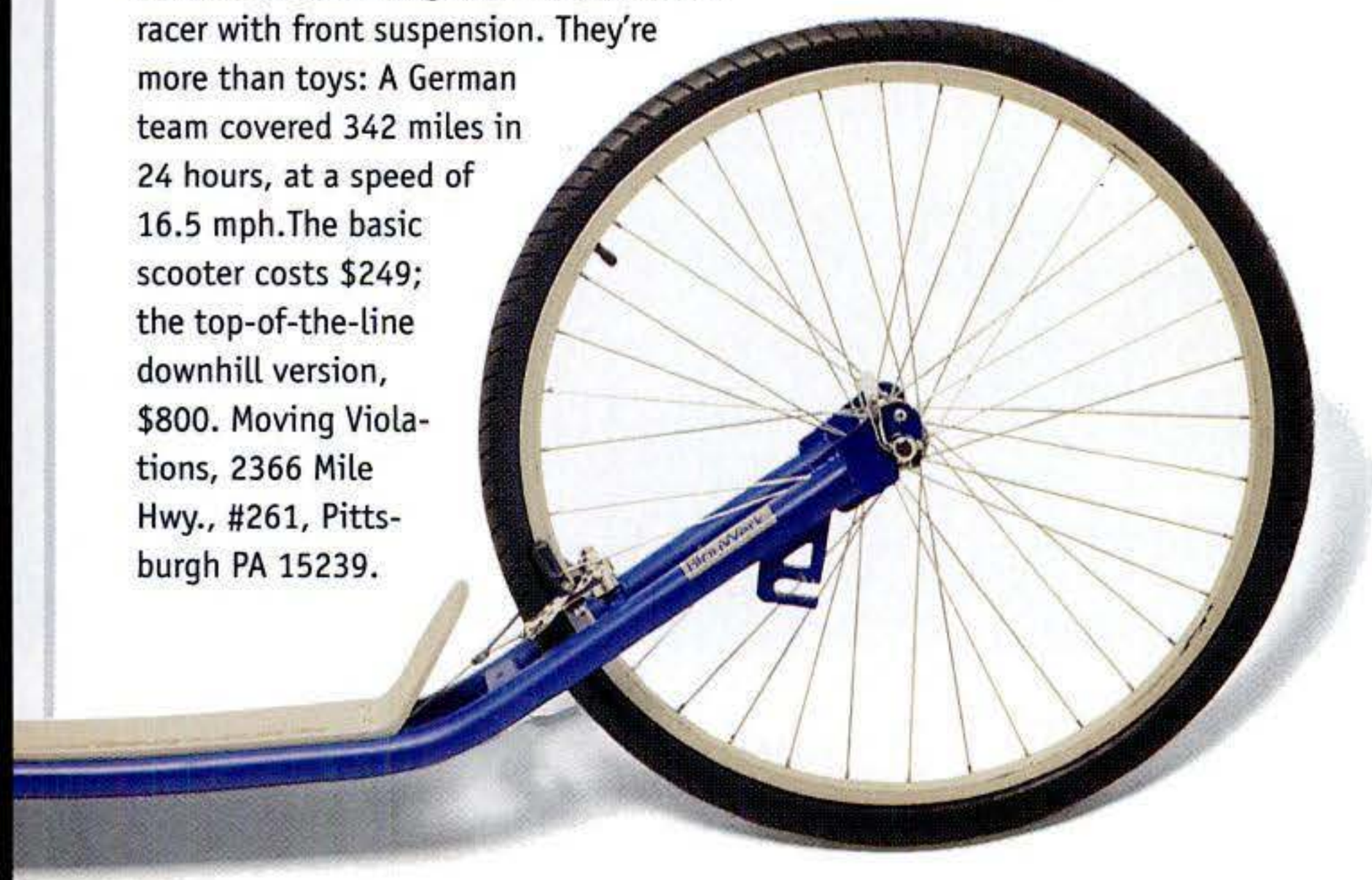
IF IT WERE A SNAKE, it might have bitten someone. But this beetle waited in collections for 85 years before being properly identified. Kipling W. Will, a graduate student, and James K. Liebherr, professor and curator of the insect collection at Cornell University in Ithaca, New York, were working through specimens when they "discovered" the beetle, now named *Platynus indecentis,* hiding among other, similar specimens. The half-inch-long predator, which lives in bogs and is a native of the Ithaca area, had never been properly identified.

A Family Jet-Boat

WITH ITS driver-up-front styling, you might mistake the Sea Doo Challenger 1800 jet-boat for a motorboat. Its two 800 series Rotax Marine powerplants deliver 220 hp through twin thrusters, easily handling the 18-foot craft's maximum load of five to seven passengers. Price: **$17,000,** with trailer. Bombardier Motor Corp., 730 E. Strawbridge Ave., Melbourne FL 32901.

Scooter for Adults

ADULT-SIZE SCOOTERS have been a craze in Austria; now, they're here. Moving Violations' Sidewalker has six models, including a 26-inch downhill racer with front suspension. They're more than toys: A German team covered 342 miles in 24 hours, at a speed of 16.5 mph.The basic scooter costs $249; the top-of-the-line downhill version, $800. Moving Violations, 2366 Mile Hwy., #261, Pittsburgh PA 15239.



Pocket PowerShot

CANON'S NEWEST digital camera, the PowerShot 350, has a larger viewing area and is less costly than the PowerShot 600; plus, it slips easily into your pocket. The $699 camera has a built-in color LCD screen and flash, a resolution of 640 by 480 pixels, autofocus, redeye reduction, and a 2MB flash memory card that holds up to 47 pictures. This model works with Windows or Mac systems and has a video-out port so you can show pictures on a TV. *www.ccsi.canon.com*

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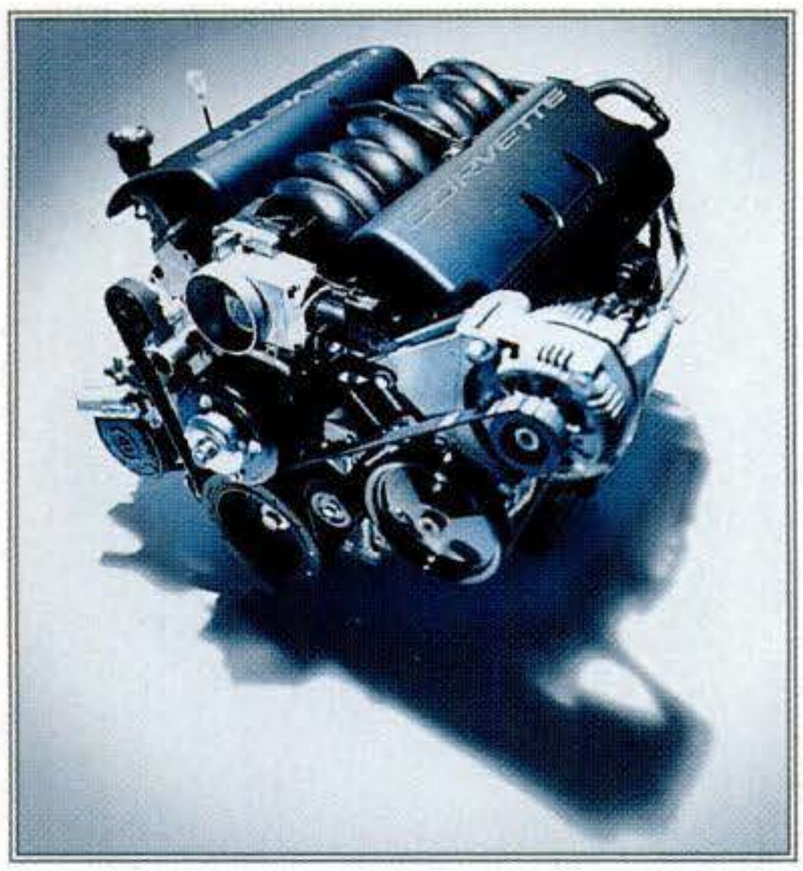
{The honest-to-goodness truth

Announcing the D

By David Hill, Chie

Of all the speculation about the new Corvette over the years, the biggest misconception was that it would be a sort of warmed-over C4.

This was because of the way we masked all of our prototypes to make them look like C4s. We certainly didn't try to dispel this notion.



{The engine is entirely new: aluminum, deep-skirt, 5.7L, 345 hp at 5600 rpm, 350 ft.-lbs. of torque at 4400 rpm.}

In fact, we were so tight-lipped about the C5 all along that I think people just assumed we had nothing to say about the car.

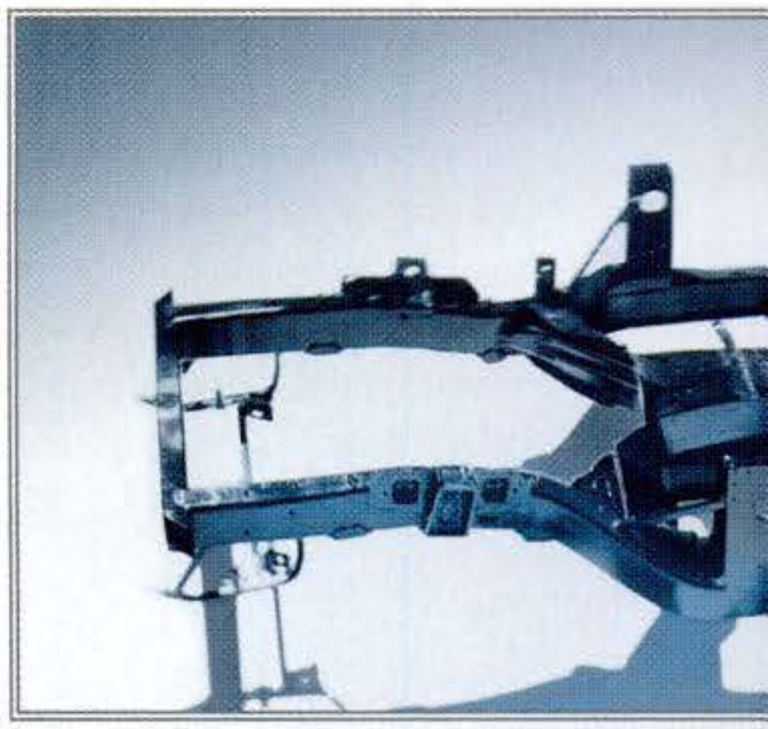
When the reporters finally drove it, they were probably a little awestruck that the Corvette had been reinvented. And, in fact, there are only a few holdover parts on the car; everything else is new. But that was the intention all along, to make the new Corvette a big surprise, a revolution.

To Change A Classic The big dilemma right from the outset was how much change to incorporate into this new car. The goal was to maintain the spirit and soul of past Corvettes. We examined the weak points and turned them into strengths. I like to say the things that were good, we made great, and things that were great are even better.

In fact, there was even some concern about making the car too civilized, and maybe people would lose their fascination with the Corvette. When this was researched, we were all surprised to find that far more important than how this car looked — three times more important — was how good it was, how dependable and reliable. This became our top priority.

Ride, Handling, Structure The performance numbers are impressive [175 miles-per-hour, 0-60 in 4.7 seconds (manual), 345 horsepower; speculation about all these numbers has been true], but it's the ride and handling that really make the C5 a different car.

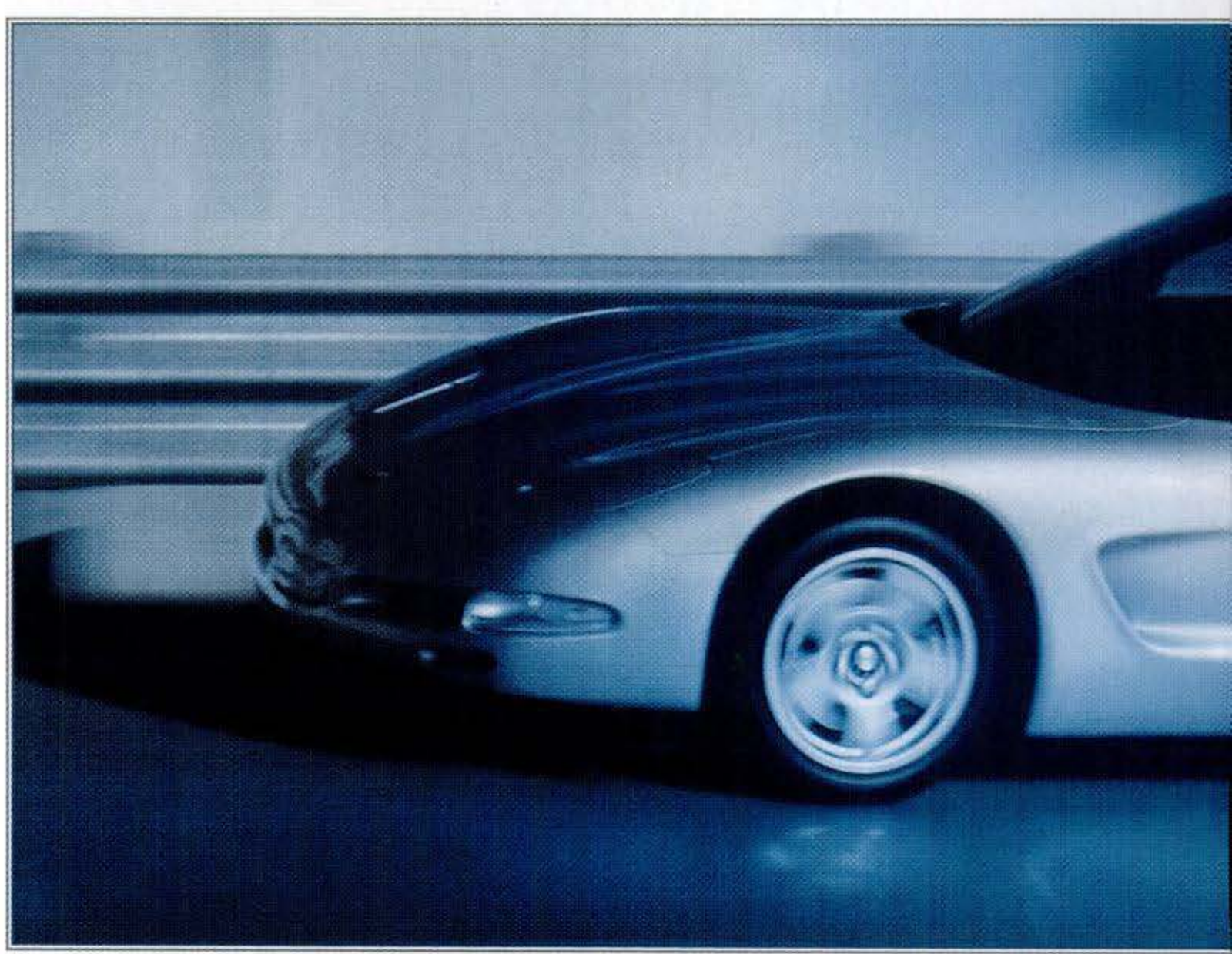
The handling is easy, natural, free of surprises; you wouldn't have any hesitation about sending a friend out to drive this Corvette. Even the most



{The new center tunnel structure and hydroformed perim

complete novice will feel the difference in ride quality. You can go 500 miles or more in one sitting and still be in really good, alert shape, with a clear head and clear hearing, because the ride has been quiet and easy.

We had some people drive the car from Ohio down to Florida and Arizona. They talked about how good they felt because the car is very kind.



T h e N e x t

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bout the C5 Corvette, after all.}

ath of Speculation.

orvette Engineer

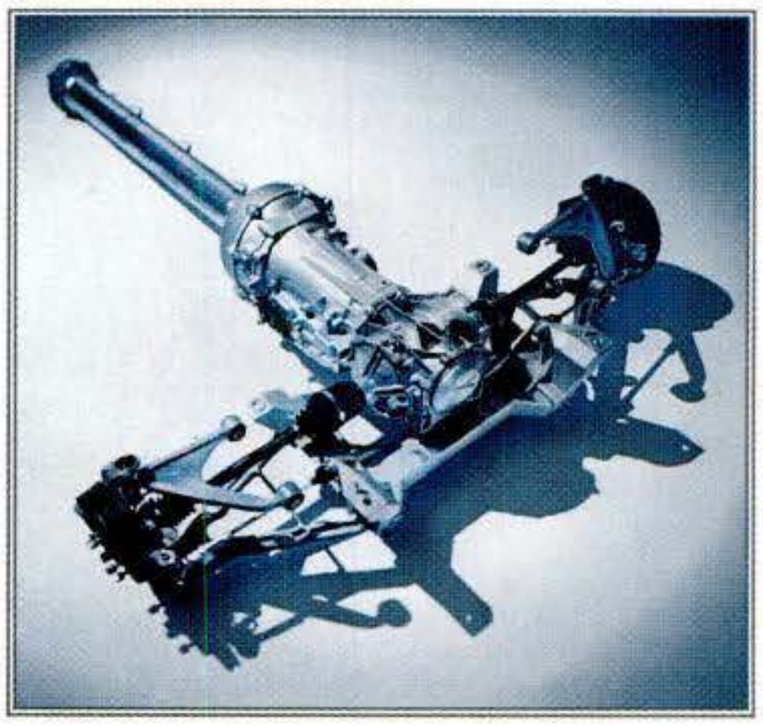
e make the new Corvette 450 percent stiffer than the C4.}

More than anything else, the improved ride is the result of increased rigidity. Structurally, the C5 is 450 percent stiffer than its predecessor, and it shows. This stiffer structure allows the new SLA (short-arm, long-arm) suspension to do its job properly.

No other car has achieved the feeling of a very expensive touring sedan, even though it's a high-performance sports car, and even though the roof is removed. In fact, the C5 has the stiffest frame of any open-roof production sports car. It's solid; it communicates an unprecedented level of goodness because of its breakthrough, best-of-class kind of structural integrity.

Entry, Egress, Leg Room Now the interior space is expanded due to the extended wheelbase and the new rear-mounted transmission and fuel system layout. There's more leg room, and we made entry and egress easier.

No matter how much someone says that a sports car should be challenging, we found that while people will put up with minor inconveniences, they'd much rather not be hassled by a car. Even sports car drivers want leg room, and they like to get in and out of their car easily. Almost everyone we asked felt the same way, from average-size people to professional football players who attended a seminar we held in Chicago.



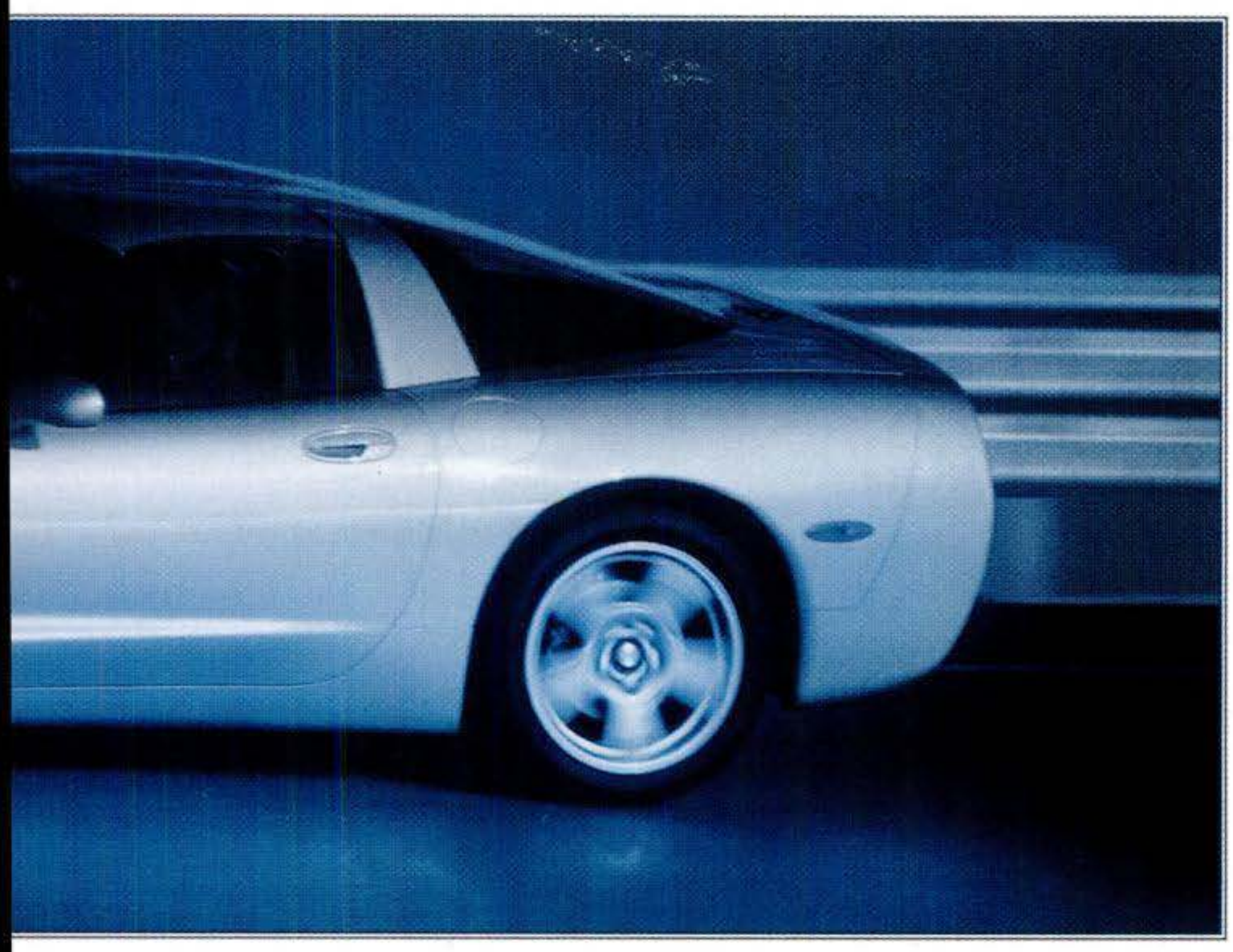
{ The C5 transmission is located in the rear for better weight distribution and increased interior space. }

The Next Corvette While the C5 is in some senses a traditional small-block V8 Corvette, it really is a different car than the Vette you've known. It's different in ways I think people will appreciate.

It's been a long, challenging project, and it's been hard to keep quiet about this whole thing all this time. Now the new Corvette is real. And now all those years of speculation end right here: with our new car, right on the showroom floor.

As for the speculators and spy photographers, I guess their work is done.

Then again, there's always '98.



Call 1-888-NEW-VETTE
or visit www.chevrolet.com

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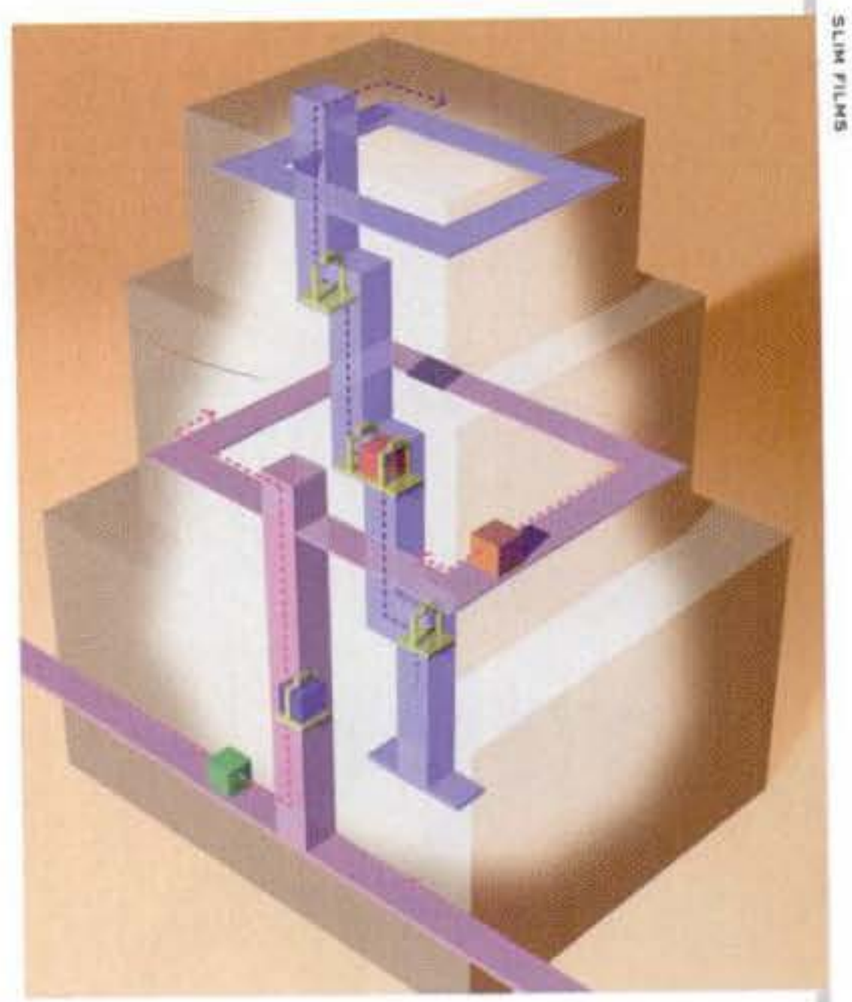
Digital Pooh

THE WINNING ways of Winnie the Pooh come to CD-ROM with Disney Interactive's Ready to Read with Pooh. Pooh teaches toddlers pre-reading skills such as letter recognition and phonics through nine whimsical activities, such as sorting his honey pots and experiencing Tigger's jack-in-the-box. The $40 disc is available for Windows or Mac. *www.disney.com*

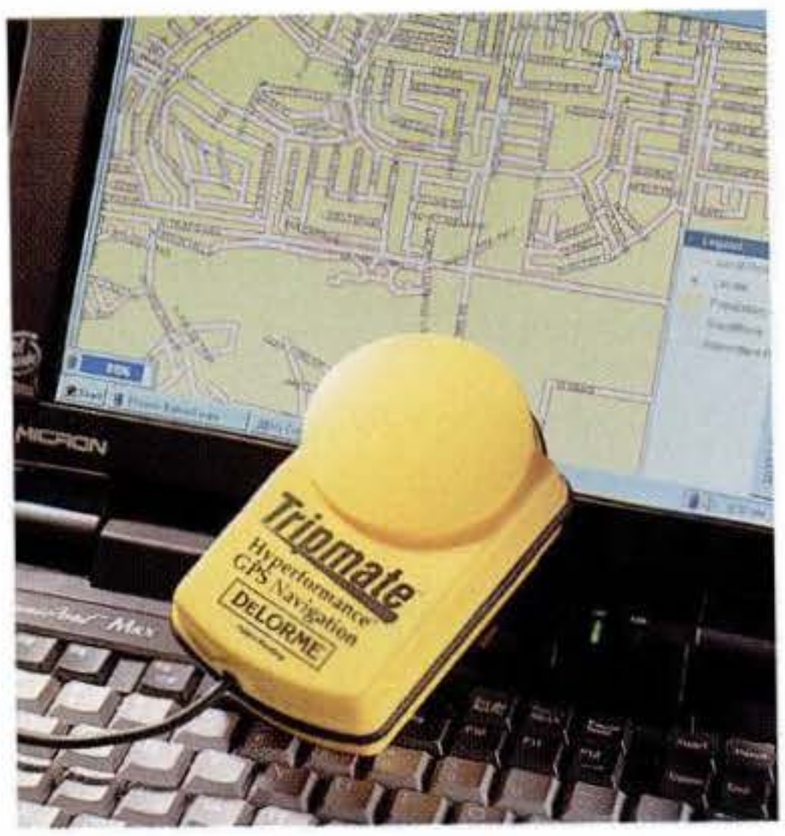
Reaching New Heights

TODAY'S TALLEST buildings rely primarily on single elevator shafts to shuttle people to the top. But this technology limits these shafts to 600 meters. For "next generation" skyscrapers, Otis' Odyssey system enables one elevator car to travel vertically and horizontally through a series of shafts to virtually unlimited heights. The system is not yet operational in any building; Otis says it is negotiating contracts. Otis, Ten Farm Springs, Farmington CT 06032.



SLIM FILMS

GPS for Laptops



DELORME IS packaging its Street Atlas USA 4.0 CD-ROM software for laptop computers, with a link to the Tripmate GPS receiver. The 12-channel receiver sits on the dashboard of your car and relays your location to the mapping software for an accurate fix. The Tripmate Hyperperformance GPS Navigation package lists for $149, making it among the lowest-priced GPS products available. DeLorme, 181 U.S. Route 1 South, Box 298, Freeport ME 04032. *www.delorme.com*

Screening Voice Mail

IN THEIR ability to receive unlimited messages, voice mail systems top answering machines, but you lose the ability to hear—and thus screen—the calls as they come in. SoloPoint's SmartScreen gives you back that ability. And just like an answering machine, the unit has an LED that indicates if a message is waiting. Price: $100. SoloPoin Inc. 130 B Knowles Drive, Los Gatos CA 95030. *www.solopoint.com*

Gigabytes to Go

SYQUEST'S NEW SyJet drive stores a whopping 1.5 gigabytes on one 3.5-inch removable hard disk cartridge, which looks like a thick floppy disk. Additional cartridges ($125 apiece) effectively give unlimited storage potential—at less than eight cents per megabyte. The SyJet is available in an internal model ($399) for Windows or Mac systems, as well as external SCSI port ($499) or parallel port ($529) models. *www.syquest.com*

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"She's sort of wrinkled and scowls a lot. She hasn't stopped screaming since the day she arrived. The dogs are *terrified*."

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Compact but Powerful

DODGE POWERS UP the compact sport-utility-vehicle market with the 1998 Durango, which boasts a 250-horsepower 5.9-liter Magnum V8. A 5.2-liter Magnum V8 and a Magnum V6 are also available. Optional bench seats in the front and rear create seating for up to eight people; rear seats fold for more cargo room. Price not yet available. *www.4adodge.com*

Tape on Demand

WITH 3M'S pop-up tape dispensers, you'll never have to line up pieces of tape on the edge of a table again. Precut, two-inch strips are dispensed from either a desktop unit ($12) or a model worn on the wrist or hand ($4). A package of three, 75-strip refill pads is $3. 3M, Stationary and Office Supplies Div., Box 33594, St. Paul MN 55133.

Digital Output

SONY'S DISCMAN D-465 is the first portable compact disc player with an optical digital output port, so you can easily copy your favorite selections to MiniDisc or other digital stereo media. The $230 unit features a 20-second buffer for electronic shock protection and 18 hours of playback with a rechargeable battery. Sony Electronics, 1 Sony Dr., Park Ridge NJ 07656. www.sony.com

Survival Machete

OWNING THIS gadget-packed machete won't make you a secret agent, but it will make a nice addition to your camping gear. Formerly available only to Soviet Special Forces, this 15-inch machete contains a shovel, ice pick, saw, compass, wrench, screwdriver, wire stripper, navigational sight, matches, and parachute cord cutter. Price: $75. Sovietski Collection, Box 81347, San Diego CA 92138. *www.sovietski.com*

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Without Intel's Video Phone, you could get the wrong impression about the new arrival.

Phone calls will never be the same. But then, neither will PCs. The Intel Pentium® processor with MMX™ technology, combined with a video phone, makes PCs more exciting and fun to use. Using an Intel Video Phone with ProShare® technology, which takes advantage of MMX media enhancement technology, will give you smoother video right over your existing phone lines.*

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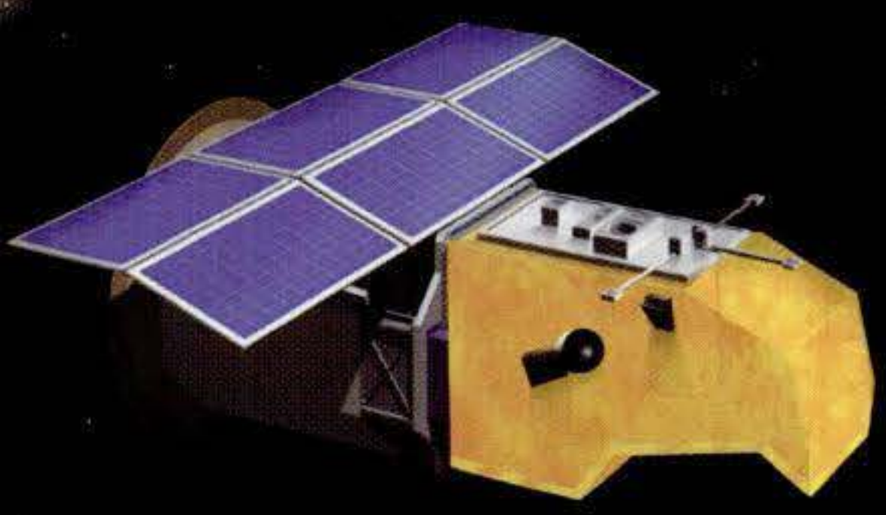
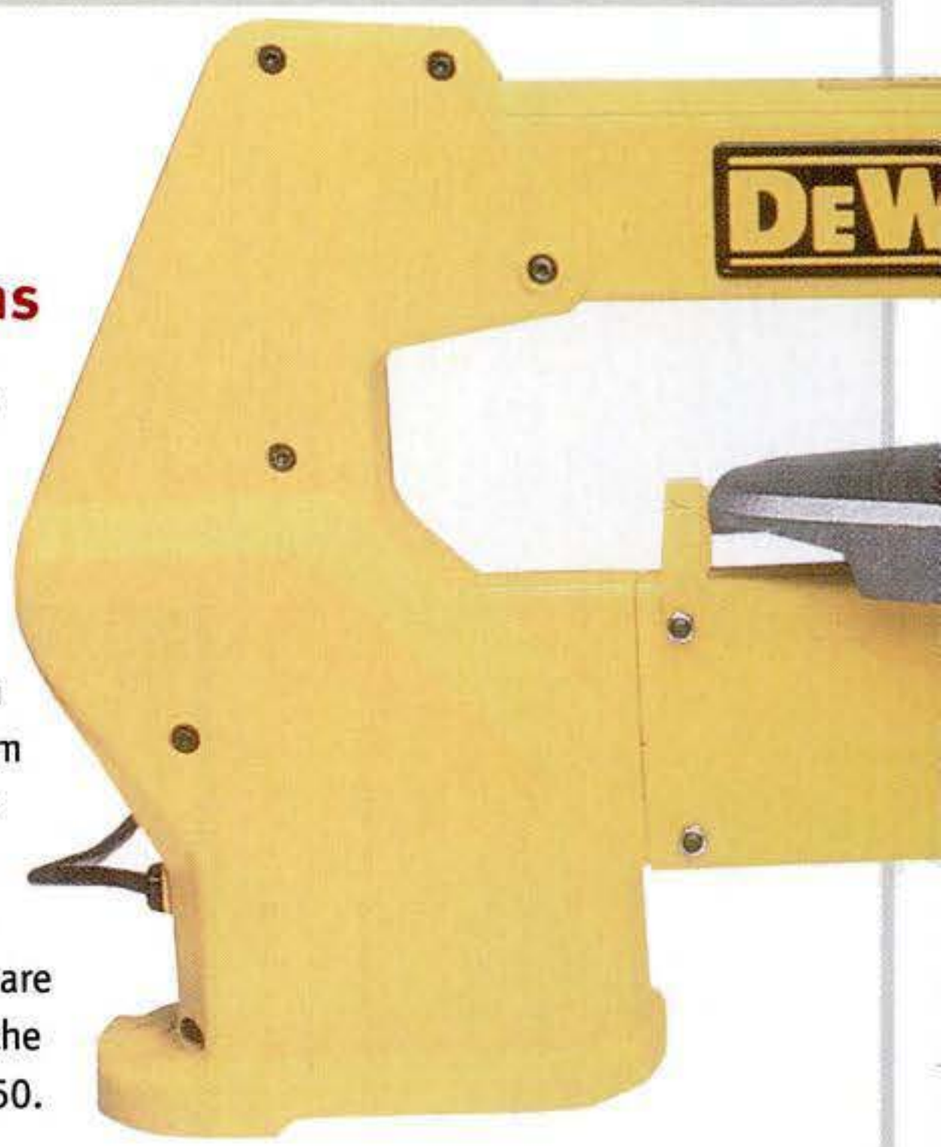
Eye in the Sky

LAUNCHING THIS summer, the EarlyBird satellite will snap images of Earth's surface that capture 11 times as much spatial detail as the best commercial satellite imagery available today, according to maker EarthWatch. Customers will be able to make online selections from the company's Digital Globe database and custom-order pictures of specific locations. EarthWatch Inc., 1900 Pike Rd., Longmont CO 80501-6700. *www.digitalglobe.com*



Good Vibrations

NOT ONLY do a scroll saw's vibrations make controlling a work piece difficult, they can be tiring for the user. The DW788 scroll saw from DeWalt tackles this problem by redesigning the saw's arm so it moves vertically from only two pivot points at the front. Controls are conveniently placed and tools are not required to change the blades. Price: $750.

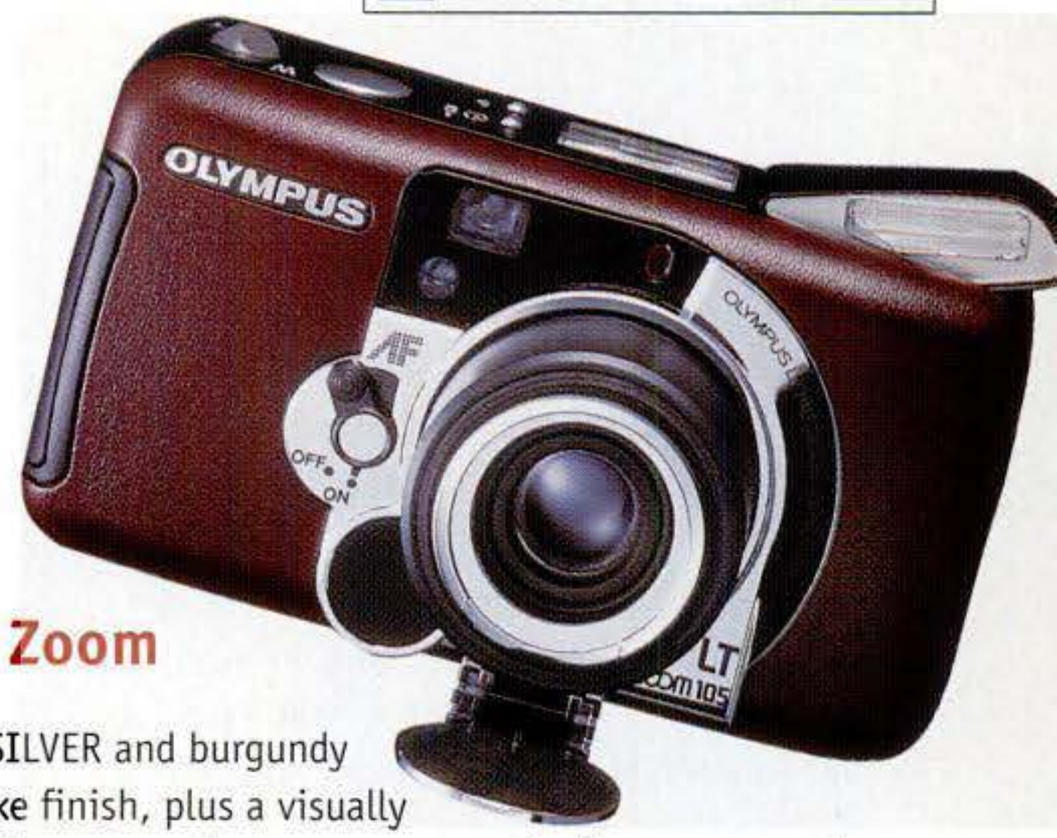


Racing With MMX

ONE OF THE FIRST TITLES written to take advantage of Intel's Pentium MMX processor, Ubi Soft's Pod gives computer racing a new sense of realism with its fast-action 3-D graphics and subtle touches like authentic shadows and skies. Set on a fictional planet where a cancerous green fungus called Pod threatens to destroy everything, the game is a contest to see who can escape. As many as eight people can play over the Internet. Price: $50. *www.ubisoft.com*

Digital Voice Recorder

OLYMPUS' DIGITAL recorder may spell the end of the microcassette. The D1000 voice recorder uses miniature flash memory cards to record digital audio. Two card sizes are available: The 2MB card stores up to 34 minutes of audio; the 4MB card, up to 72. Files can be downloaded to a computer and sent over phone lines in a compressed format to reduce transmission time. The D1000 lists for $250; 2MB cards are $50 each and 4MB cards cost $100. Olympus, Two Corporate Center Dr., Melville NY 11747-3157. *www.olympus.com*



Retro Zoom

WITH A SILVER and burgundy leatherlike finish, plus a visually dramatic lens cover that opens automatically upon use, the Olympus LT Zoom 105 has a stylish retro look. But this $419 camera isn't all good looks. Features include a 35-105mm zoom lens and a 776-step auto-focus system. Its handy night-scene mode synchronizes the flash with a slow, four-second shutter speed to capture the full image. Olympus America, Two Corporate Center Dr., Melville, NY 11747-3157. *www.olympus.com*

Invisible Fresheners

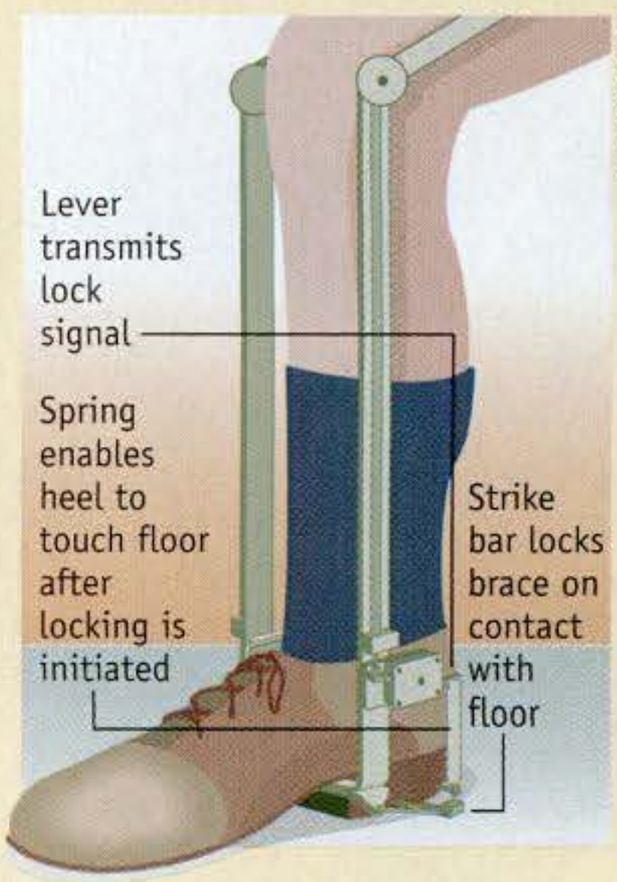
KEEP YOUR CAR smelling new, without air fresheners in view. Ventsations Scent Clips slide directly into your car's air vents. They come in six fragrances and colors. Price: $2.50. Dakota Products Inc., Box 1550, Sioux Falls SD 57101.

Local Cruiser

BOMBARDIER'S NEIGHBORHOOD Electric Vehicle, or NEV, is not your average golf cart. Traveling along at up to 25 mph with a range of about 30 miles, the NEV is designed to zip you around residential communities or fairways in sedanlike style. The NEV runs on six rechargeable lead-acid batteries and has an onboard 110-volt charger. A golf package with turf tires and golf bag holder is available. Detachable doors are optional. List price: $6,699. *www.nev.bombardier.com/*

Dual-Position Brace

FOR PATIENTS who have suffered strokes or knee injuries, doctors often prescribe a knee brace that holds the leg in a rigid, straight position. But such a brace can be painfully restrictive. Instead, the Selectively Lockable Knee Brace, invented at NASA's Marshall Space Flight Center in Huntsville, Alabama, lets the knee bend but locks in position when weight is put on the heel. This allows rehabilitation to begin before the knee can carry the full weight of the patient.



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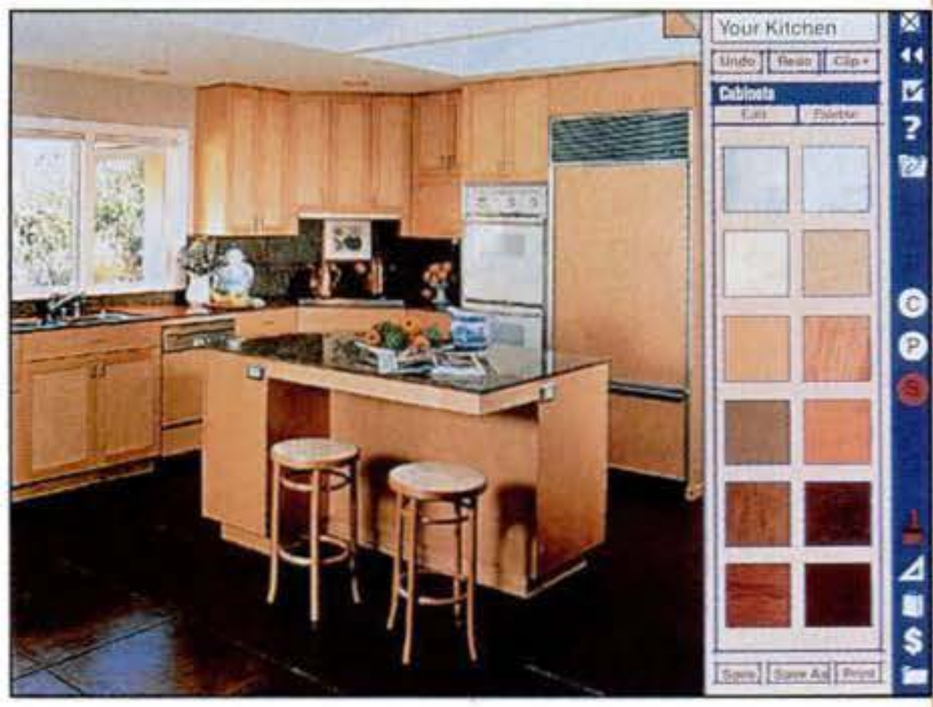
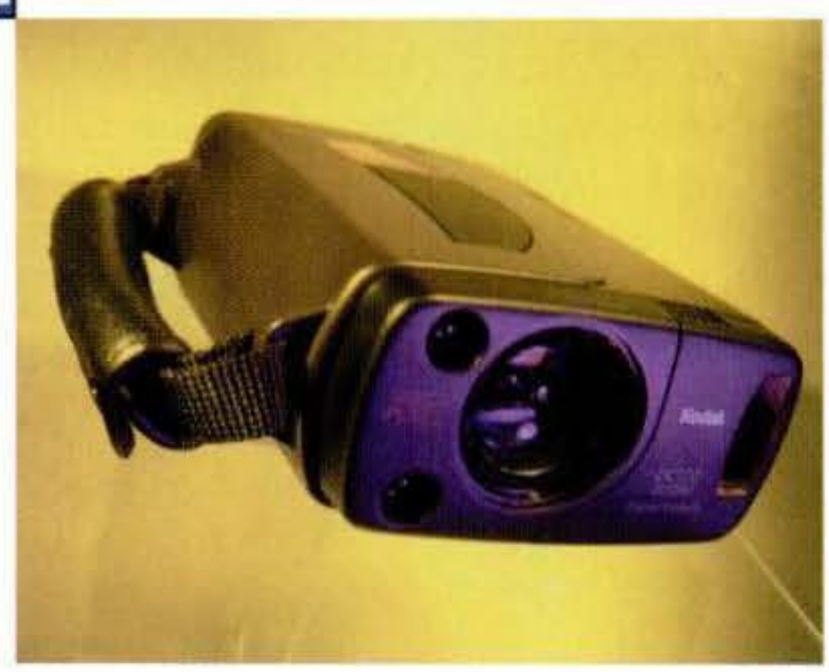
Four-Door Pickup

DOUBLE THE DOORS means double the access in Dodge's 1998 Ram Quad Cab, which the company touts as the first full-size pickup to offer dual access doors to the rear seat. It comes with a choice of powertrains that includes the full-size 8.0-liter V10 and Cummins Diesel engines. An improved instrument panel plus a passenger-side airbag and heated power mirrors round out the 1998 model. Pricing for the Ram Quad Cab will be available this fall. *www.4adodge.com*



Kitchen Remodeler

PICTURE THIS Home Kitchen software shows how components will look together, before you remodel. You select brand-name appliances, windows, and countertops. You can experiment with wallpaper or paint. Price: $50. Autodesk, 111 McInnis Pkwy., San Rafael CA 94903.

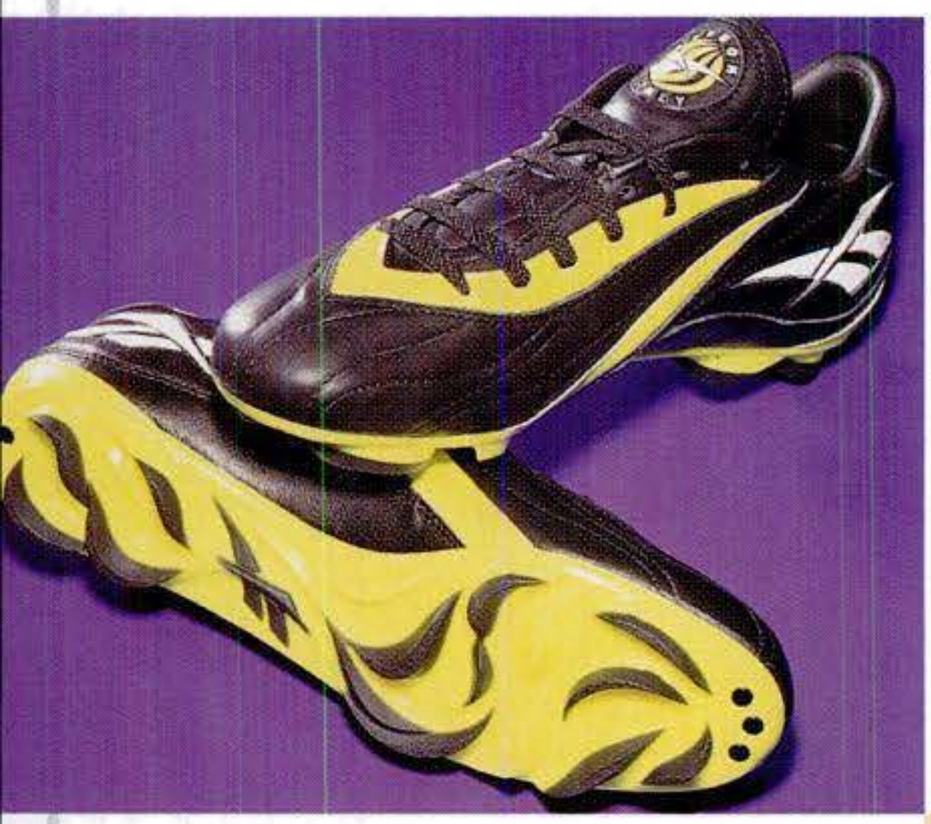


Digital with Zoom

KODAK'S DC120 is one of only a few digital cameras to have a 3x zoom lens. Its resolution of 1,280 by 960 pixels also raises the bar for digital cameras priced at less than $1,000. Eastman Kodak, 901 Elmgrove Rd., Rochester NY 14653-5245. *www.kodak.com*

A New Screen Phone

PRESS 1 TO HEAR your current balance; press 2 to check on a payment. Sybil, a phone with small LCD keys, takes these phone tree options and displays them on its LCD keypad. The software that drives Sybil applications resides on your PC, not at the company you are calling, so the first consumer applications are likely to be phone banking and contact databases. The manufacturer expects the first consumer applications to be available late this year. Intrinsic Solutions, 5 Lafayette Rd., Hampton NH 03842. *www.sybil.com*



Rad Soccer Shoes

REEBOK'S SIDEWINDER Pro Evolution GSC soccer shoes sport more than a long name and a radical look. Instead of traditional molded studs, teeth of thermoplastic urethane ripple across the outer sole. The teeth have 30 percent more surface area to grip the turf than conventionally studded shoes, and the patterns are designed to add greater support and flexibility. Available in June for $95. Reebok International, 100 Technology Center, Stoughton MA 02072.

"Office" on Wheels

WITH A built-in "desk," the Think Fast Chair lets you and your portable PC compute in comfort...anywhere. Oversize wheels and a rear handle enable you to move the workspace to, say, the TV room, with ease. The custom-made chair is constructed with a hardwood maple frame. Prices start at about $1,000. Martin Brattrud, 1224 West 132nd St., Gardena CA 90247.

Remote Control Sunshine

REMOTELY CONTROLLED window shades are convenient, but in the past, they required cords or hard wiring. Duette PowerRise blinds run on batteries and can be programmed to raise and lower to preset positions. A safety mechanism stops the blind from descending if an object is in its path. A standard 4- by 5-foot shade costs $657. Hunter Douglas, 1 Duette Way, Broomfield CO 80020.

Changes Beneath the Skin

THE FORD RANGER gets some engine upgrades for 1998. The Ranger comes with a 2.5-liter inline four producing 118 horsepower, a 10 percent power increase over the previous model year. The 3.0-liter V6 improves torque to 178 foot-pounds at 3,750 rpm, also a 10 percent increase. All models allow quiet, instant 4x4 engagement at any speed. Pricing is not yet available. *www.ford.com*

Bigger Photos

HEWLETT-PACKARD'S PhotoSmart photo printer delivers 8- by 10-inch prints at near-photo-finishing-lab quality. The dedicated printer can also handle regular paper, but it's not recommended for use as a general printer, since its output is only 300 dpi. Microsoft's Picture It! photo editing software is bundled with the $500 printer. Hewlett-Packard, 3000 Hanover St., Palo Alto CA 94304. *www.hp.com*

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NEWSFRONTS

COMPUTERS & SOFTWARE

EDITED BY CHRIS O'MALLEY

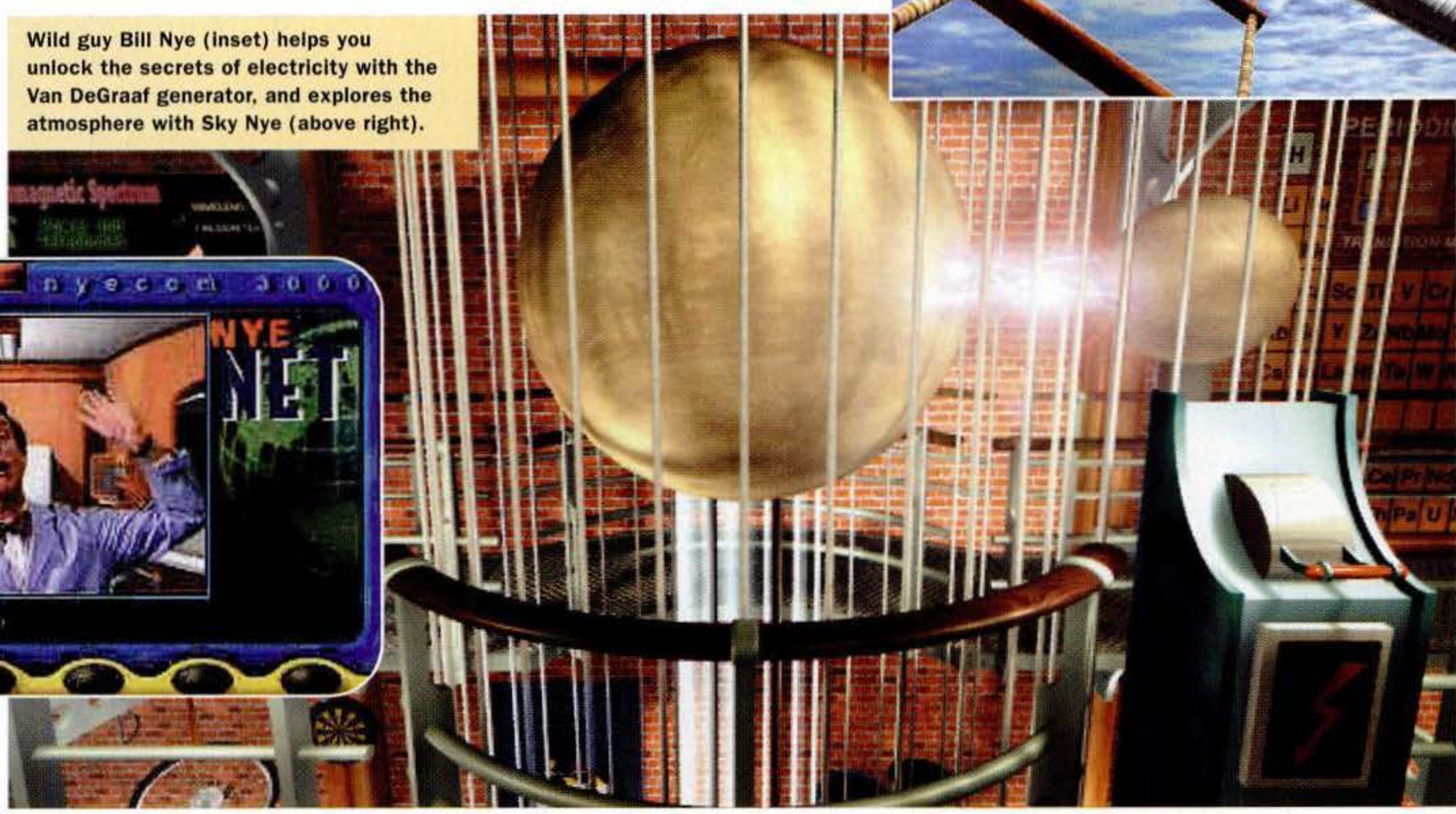
HANDS ON

Slapstick Science

THIS IS NOT your father's science textbook. But then, if you've caught Bill Nye's manic version of science education on TV in "Bill Nye the Science Guy," you already knew that. What you may not know is that his purposeful play has now come to CD-ROM.

The zany scientist and his peculiar laboratories translate fairly well in Bill Nye the Science Guy: Stop the Rock! ($40 for PCs or Macs), thanks to realistic 3-D graphics and frequent video clips of Bill and pals on the "Nyecom 3000" monitor. Designed for young scientists ages nine and up, the program leaves you to wander through the three floors of Nye Labs, encountering odd devices that help explain concepts in earth sciences. In the process, you gather clues that can help prevent a gigantic meteoroid from hitting Earth (hence the title).

Adults over 30 and other linear thinkers won't much care for the haphazard, often vexing process of finding and figuring out the devices and clues, but that approach may be just fine for the Myst generation. The program's only serious flaw is its depth, or lack thereof. Many of its devices—like the Weatherator, in which you specify warmer or cooler variables to see weather conditions such as fog develop—are too simplistic, and don't invite many replays. But Stop the Rock! is the first of a planned series, so we may yet see more science within the adventure.—C.O.



Wild guy Bill Nye (inset) helps you unlock the secrets of electricity with the Van DeGraaf generator, and explores the atmosphere with Sky Nye (above right).

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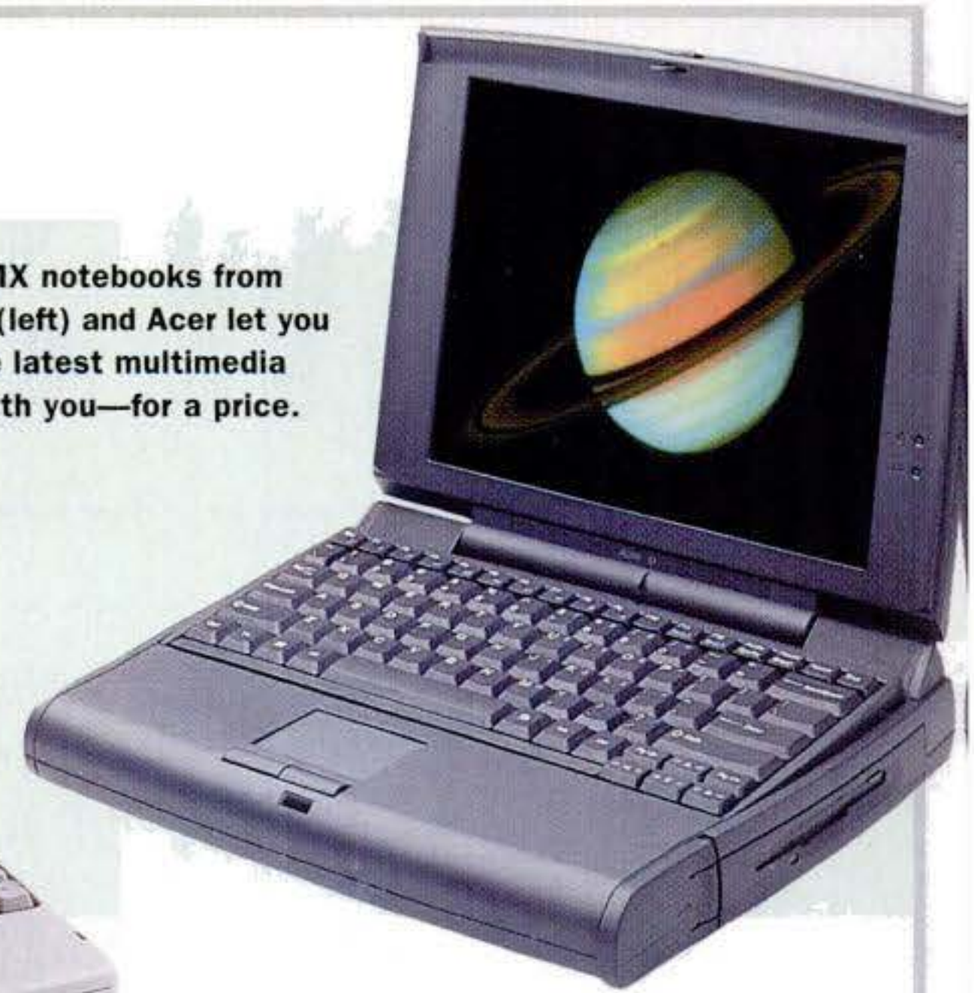
PORTABLE PCs

Mobile MMX



New MMX notebooks from Toshiba (left) and Acer let you take the latest multimedia sizzle with you—for a price.

AS EXPECTED, the multimedia-enhancing MMX versions of Intel's Pentium microprocessors are showing up in many of the latest desktop PCs from Compaq, Dell, IBM, Gateway, and others. What's surprising is how quickly they're showing up on airplane tray tables.

A squadron of MMX portable computers—including ones from the nameplates above, plus Acer, Digital, NEC, Texas Instruments, Toshiba, and Micron—has landed, or soon will. All use either a 150- or 166MHz Pentium MMX chip, so they're not flying quite as fast as desktop MMX models, which typically use 200MHz chips. But the MMX impact is the same. Essentially, MMX technology adds 57 new instructions to the basic code of a Pentium processor, most of them designed to handle audio and video tasks more quickly. Existing Windows software works just fine on MMX chips, but programs must be specially written (or modified) to take advantage of the new instructions.

Acer's AcerNote Nuovo 975 ($4,600), IBM's ThinkPad 760XD ($6,500), NEC's Versa 6050MX ($5,200), and Toshiba's Tecra 740CDT ($6,100) are among the new wave of flashy, pricey MMX laptops. By year end, higher-speed MMX chips are expected to make their way into portables, with the current chips moving down the food chain and into more moderately priced laptops.—*C.O.*

COMPUTER VIRUSES

Immunizing the Net

A COMPUTER VIRUS can cause as much discomfort, or even more, than some of its biological counterparts. And, unfortunately, new viruses seem to pop up faster than new flu strains during the cold season. Now, IBM researchers are taking a hint from medical research by following a similar epidemiological model in studying and hopefully quelling the spread of computer viruses.

In the same way medical researchers gather evidence about viruses, the IBM research team is tracking information based on computer virus infestations, and using simulations to test how a virus spreads. Based on this model, the team hopes to be able to develop the equivalent of an immune system for computers.

Although the research is still ongoing, the potential payoff is huge. Rather than be reactive and develop an antidote for each new virus as it is discovered, scientists would let the immune system do the work. The system, they hope, would allow a computer to develop its own "antibodies" to fight new and previously unknown viruses. These computer antibodies would work much as human antibodies do, recognizing and remembering infections, and consequently responding to them more rapidly and effectively.

According to Steve White, senior manager of the High Integrity Computing Laboratory at IBM's Thomas J. Watson Research Center, technology such as this will be key as the Internet spreads new virus strains faster and faster. "Today's viruses are only the tip of the iceberg," says White. Some of this technology is already used in IBM's AntiVirus software.—*Jon Pepper*

PERSONAL FINANCE

United Online Bank

TODAY, DOING YOUR banking online means buying into one company's software and vision of what an electronic checkbook should do—often with a limited choice of participating financial institutions. But that may soon change.

Microsoft, Intuit, and Checkfree—which have each sought to recruit customers and banks to their particular brands of online banking—have agreed to eschew their proprietary systems in favor of a common scheme, known as the Open Financial Exchange (OFX) specification. Visa and others are expected to join the coalition soon. Among other things, OFX paves the way for more banks to do business electronically by removing the fear of investing in the wrong company's technology.—*C.O.*

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CD-ROM

DVD-It-Yourself

REMEMBER WHEN CD-ROM drives were novel add-ons that came in an assortment of upgrade kits? Well, as Yogi would say, it's like déjà vu all over again—this time with the DVD-ROM drives that are based on digital videodisc technology.

Creative Technology, Diamond Multimedia, Panasonic, and STB are each set to begin selling DVD-ROM upgrade kits this spring. The first kits are expected to cost between $500 and $1,000, and will include the DVD-ROM drive and an MPEG-2 video card with Dolby AC-3 surround-sound support. While only a handful of DVD-ROM titles likely will be available before summer (mostly phone directories and encyclopedias), DVD-ROM drives can also play existing CD-ROM discs, music CDs, and new DVD movies. DVD discs can hold at least seven times as much data as CD-ROM discs.

Panasonic's DVD-ROM kit lets you buy a piece of the future today.

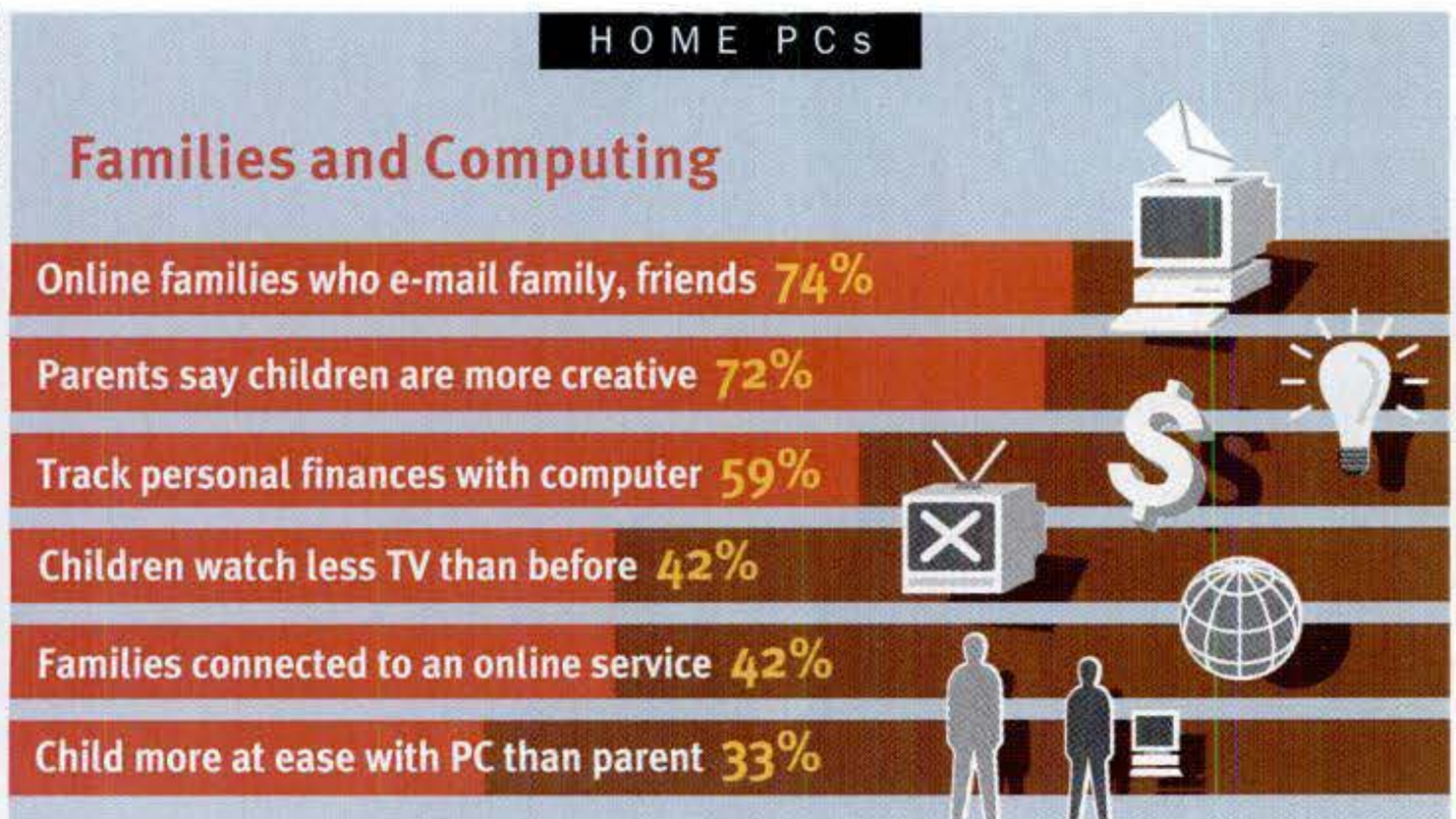
Eventually, as more titles appear and the cost of the hardware drops, DVD-ROM drives are expected to become standard equipment in desktop PCs, just as CD-ROM drives have. Already, a number of PC makers—including Gateway and Hewlett-Packard—say they plan to include DVD-ROM drives in some systems by summer. Gateway says it will add a DVD-ROM drive to one or more of its Destination PC-TV models, for example.

At least one PC maker has already delivered DVD in a home PC. Toshiba's new Infinia 7220, which runs on a 200MHz Pentium MMX processor, comes with a built-in DVD-ROM drive in place of a standard CD-ROM drive. The drive is designed to play CD-ROM titles at 8X speeds, and 9X for DVD-ROM discs. It comes with two DVD titles: Leopard Sun/Animal Planet and Forrest Gump. No price has been set—*C.O.*

HOME PCs

JOHN GRIMWADE

Families and Computing



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The Easter Egg Archive
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Comet Observation Home Page
encke.jpl.nasa.gov/
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—Suzanne Kantra Kirschner

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SPACE

Orbiting Lifeboat

WHAT IF AN illness or mishap occurs aboard the future international space station, and astronauts need to return to Earth quickly? NASA's solution is to have a lifeboat docked at the station at all times. The space agency has commissioned an experimental "crew return vehicle," called the X-38, that will test the idea of bringing as many as six spacefarers home to a soft parachute touchdown—instead of the tricky high-speed landing a space shuttle makes.

Following re-entry into the atmosphere and deceleration to subsonic speed, the unpiloted craft would use a steerable, ram-air parafoil to make an automated landing at about 40 mph. This spring, a NASA B-52 flying 40,000 feet above Edwards Air Force Base in California will launch a prototype of the 24-foot-long X-38 on gliding flights that will test the landing concept.

Built by aerospace engineer Burt Rutan's Scaled Composites in Mojave, California, the unpowered X-38 borrows its lifting-body shape from the Martin X-24 flown in the 1970s during space-shuttle development. If the X-38 performs as predicted, NASA wants it in orbit by 2002. —*Stuart F. Brown*

NASA

The X-38 could bring astronauts back to Earth in an emergency.

NATURE

Listening Lungs

DESPITE BEING earless, the Panamanian golden frog appears to respond to sounds made by other members of its species. According to zoologists at Ohio State University, the unusual frog "hears" through its lungs.

The lungs lie close to the surface of the frog's body and vibrate when sound waves strike the animal's brilliantly colored skin. "In a sense, the frog's lungs act as eardrums," explains Thomas Hetherington, an Ohio State professor who studies the animal.

Although the golden frog does not have the middle and external ears of a typical three-part amphibian ear, it does have an inner ear. Scientists are not sure how sound signals travel between the lungs and the inner ear to enable the frog to hear.

The frog lives along remote mountain streams, where the noise of rushing water makes it difficult to hear other sounds in the environment. Scientists studying Panamanian golden frogs have observed that the frogs regularly communicate using hand signals, waving their forearms at each other. Further studies of this species may provide clues about the evolution of hearing.—*D.S.*

The earless Panamanian golden frog picks up sound waves through the walls of its lungs.

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PHYSICS

Atom Laser

TWO YEARS AGO, physicists created a new state of matter called a Bose-Einstein condensate—a dense swarm of atoms that behave like a single particle when frozen to near absolute zero. Now researchers at MIT have taken the discovery a step further and invented a new kind of laser based on the condensate.

An optical laser, like those in CD players, produces coherent waves of light made of photons traveling in lockstep. This enables the laser to emit narrow, focused beams. The new "atom laser" packages millions of atoms into similarly coherent pulses. It works only in a vacuum, so its practical uses are limited. But it could lead to more precise atomic clocks, and to tiny computer circuits made by depositing individual atoms on a chip.—*Arthur Fisher*

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DINOSAURS

Feathered Fossil

DID DINOSAURS of a feather flock together? The widely held theory that birds evolved from dinosaurs recently got a boost from a feathered fossil discovered in China. But other Chinese fossils suggest that birds may not have descended directly from dinosaurs, but from an earlier common ancestor.

Philip J. Currie of Canada's Tyrell Museum of Paleontology and Chen Peiji of Beijing University recently unveiled a remarkable fossil: the first true dinosaur with birdlike, downy feathers. Scientists have long suspected that feathers might have initially evolved for insulation, like hair or fur, and later became adapted for flight. The feathery find is a three-foot-long carnivorous animal discovered by farmers in the Liaoning province of northeastern China. It walked upright, and probably ate fish.

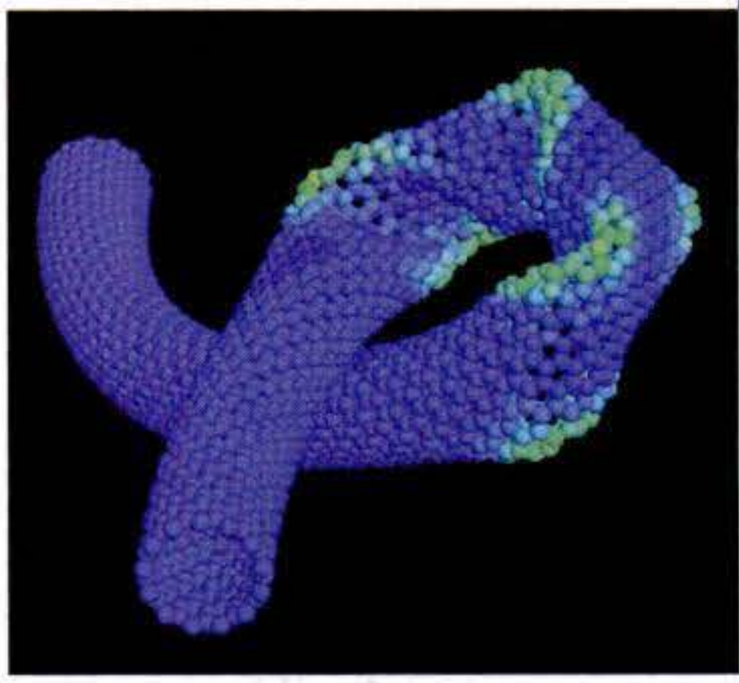
Meanwhile, other fossils found by farmers in the same area are casting doubt that birds evolved from dinosaurs. A team led by Alan Feduccia of the University of North Carolina at Chapel Hill says these fossils belonged to an ancient bird the size of a sparrow, called *Liaoningornis*. It lived about 140 million years ago, earlier than the famous birdlike Jurassic creature called *Archaeopteryx*, yet it displayed more advanced physical features. For instance, it had the breastbone shape necessary for flight. *Archaeopteryx*, which did not have this type of breastbone, may have glided rather than flown.

The *Liaoningornis* findings suggest that *Archaeopteryx* may have been an evolutionary dead end and that, rather than evolving from dinosaurs, birds may have simply shared a more ancient common ancestor.—*Mariette DiChristina*

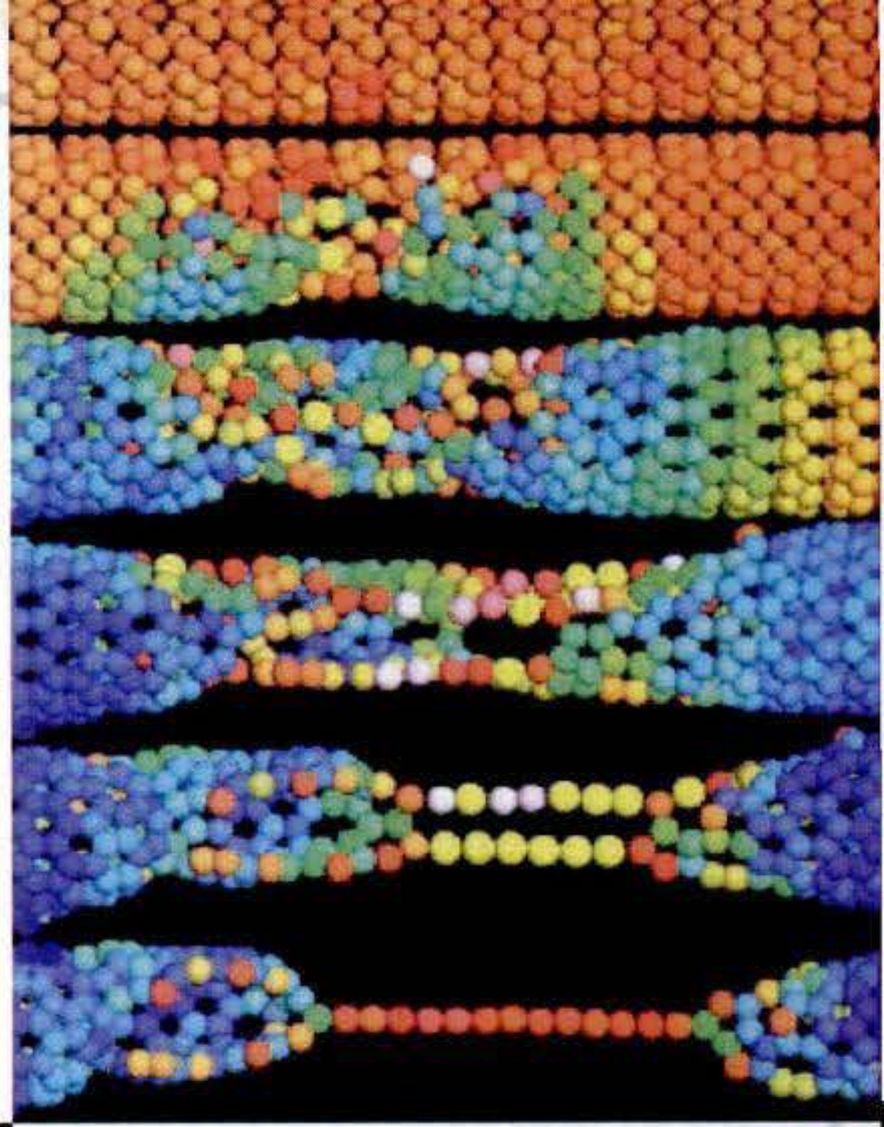
NANOTECHNOLOGY

Going Up?

THE IDEA OF a space elevator is getting a lift from a group of American physicists. Two decades ago, science-fiction writer Arthur C. Clarke conceived the simple yet fanciful notion of dangling a cable 23,000 miles to Earth's surface from a satellite in synchronous orbit, and using the cable to operate a space elevator. Since no material existed that would not snap under its own weight when extended to that distance, Clarke's fictional scientists proposed using a cable composed of filaments of carbon.



Clarke's idea might not be so far-fetched, according to Boris Yakobson and two other physicists at North Carolina State University. In a computer simulation, they found that a honeycombed tube of carbon atoms, called a nanotube, was capable of withstanding tension of as much as 200 gigapascals—the equivalent of supporting a 20-ton load on a one-millimeter-thick carbon thread. The magic number required for a space-elevator cable is only 60 to 70 gigapascals.



Computer-simulated carbon nanotubes stretch, twist, and bend without breaking.

According to the simulation, carbon nanotubes can stretch by 40 percent without breaking. The tiny tubes are siblings of buckyballs in the fullerene family.—*Douglas Page*

ASTRONOMY

A Cosmic Rerun?

THE SPECTACULAR collision of Comet Shoemaker-Levy 9 with Jupiter in 1994 captivated astronomers around the world. Now a Japanese amateur astronomer has found evidence that a similar collision may have caught the attention of a 17th century astronomer.

On December 5, 1690, Giovanni-Dominique Cassini, then director of the Paris Observatory, noticed a dark spot that suddenly appeared on Jupiter, and then faded over the following 18 days. Although Cassini couldn't explain what caused the spot, he recorded his observations in a slim book published in 1692.

After the Shoemaker-Levy collision, Isshi Tabe wondered if previous comet impacts had ever been observed. He began digging through astronomical archives and found the long-forgotten Cassini book in the Paris Observatory's library. He was surprised to see how closely the appearance and fading of the spot described by Cassini resemble what astronomers saw when they looked at the bruises left by Shoemaker-Levy. Tabe is now urging observatories to search their archives for other sightings.—*Dennis Normile*

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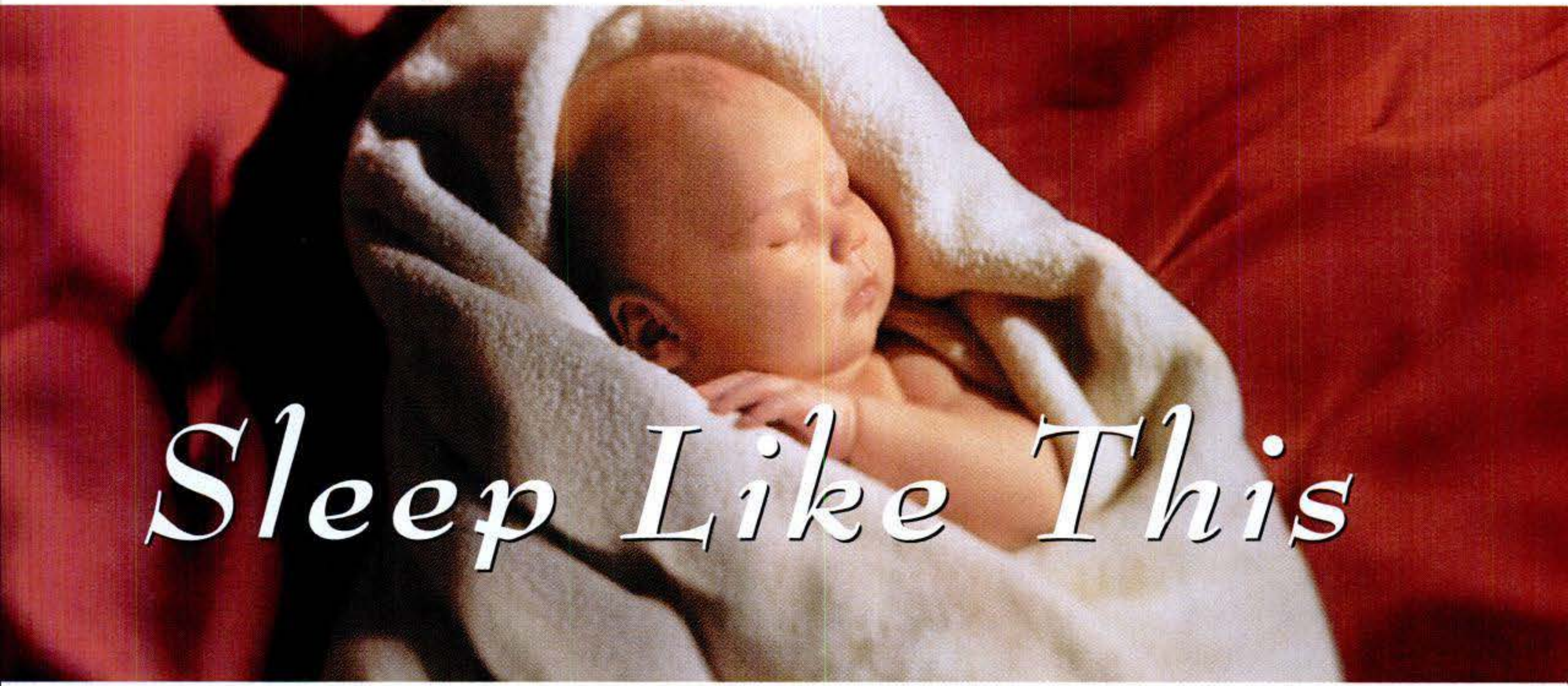
Now men who suffer from frequent nighttime urination can...



CARDURA®. The fast, easy treatment for frequent nighttime urination due to BPH.

Frequent nighttime urination is a common and bothersome symptom of benign prostatic hyperplasia (BPH), a noncancerous enlargement of the prostate gland occurring most often in men over the age of 50.

Cardura is a simple, once-daily tablet that quickly relieves urination problems caused by BPH, meaning your bladder can empty completely and you won't have to wake up as often at night to go to the bathroom.

Cardura may begin to improve urinary flow—day and night—in as little as 1 to 2 weeks.

Cardura is available only by prescription.
So ask your physician if **Cardura** is right for you—if it is, your doctor can provide you with a trial pack to get you started.

Cardura can cause a sudden drop in blood pressure at the beginning of treatment or if you miss doses and then start taking the medication again. You may feel dizzy, faint, or light-headed, particularly after getting up from a chair or bed. Speak to your doctor about oral medications like Cardura and other treatment options for BPH such as regular monitoring of the condition or surgery.

Please see important information on the next page.

ONCE-A-DAY
CARDURA®
(doxazosin mesylate) Scored Tablets 1 mg, 2 mg, 4 mg, 8 mg

Cardura. Because BPH shouldn't be something to lose sleep over.

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ONCE-A-DAY
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PATIENT INFORMATION ABOUT CARDURA®
Generic Name:
doxazosin mesylate
FOR BENIGN PROSTATIC HYPERPLASIA (BPH)

Read this information:

- before you start taking CARDURA®
- each time you get a new prescription.

You and your doctor should discuss this treatment and your BPH symptoms before you start taking CARDURA® and at your regular checkups. This information does NOT take the place of discussions with your doctor.

CARDURA® is used to treat both benign prostatic hyperplasia (BPH) and high blood pressure (hypertension). This information describes CARDURA® as treatment for BPH (although you may be taking CARDURA® for both your BPH and high blood pressure).

What is BPH?

BPH is an enlargement of the prostate gland. This gland surrounds the tube that drains the urine from the bladder. The symptoms of BPH can be caused by a tensing of the enlarged muscle in the prostate gland which blocks the passage of urine. This can lead to such symptoms as:

- a weak or start-and-stop stream when urinating
- a feeling that the bladder is not completely emptied after urination
- a delay or difficulty in the beginning of urination
- a need to urinate often during the day and especially at night
- a feeling that you must urinate immediately.

Treatment Options for BPH

The four main treatment options for BPH are:

- If you are not bothered by your symptoms, you and your doctor may decide on a program of "watchful waiting." It is not an active treatment like taking medication or surgery but involves having regular checkups to see if your condition is getting worse or causing problems.
- Treatment with CARDURA® or other similar drugs. CARDURA® is the medication your doctor has prescribed for you. See "What CARDURA® Does," below.
- Treatment with the medication class of 5-alpha reductase inhibitors (e.g. Proscar®). It can cause the prostate to shrink. It may take 6 months or more for the full benefit of finasteride to be seen.
- Various surgical procedures. Your doctor can describe these procedures to you. The best procedure for you depends on your BPH symptoms and medical condition.

What CARDURA® Does

CARDURA® works on a specific type of muscle found in the prostate, causing it to relax. This in turn decreases the pressure within the prostate, thus improving the flow of urine and your symptoms.

- CARDURA® helps relieve the symptoms of BPH (weak stream, start-and-stop stream, a feeling that your bladder is not completely empty, delay in beginning of urination, need to urinate often during the day and especially at night, and feeling that you must urinate immediately). It does not change the size of the prostate. The prostate may continue to grow; however, a larger prostate is not necessarily related to more symptoms or to worse symptoms. CARDURA® can decrease your symptoms and improve urinary flow, without decreasing the size of the prostate.
- If CARDURA® is helping you, you should notice an effect within 1 to 2 weeks after you start your medication. CARDURA® has been studied in over 900 patients for up to 2 years and the drug has been shown to continue to work during long-term treatment.

  Even though you take CARDURA® and it may help you, CARDURA® may not prevent the need for surgery in the future.
- CARDURA® does not affect PSA levels. PSA is the abbreviation for Prostate Specific Antigen. Your doctor may have done a blood test called PSA. You may want to ask your doctor more about this if you have had a PSA test done.

Other Important Facts

- You should see an improvement of your symptoms within 1 to 2 weeks. In addition to your other regular checkups you will need to continue seeing your doctor regularly to check your progress regarding your BPH and to monitor your blood pressure.
- CARDURA® (doxazosin mesylate) is not a treatment for prostate cancer. Your doctor has prescribed CARDURA® for your BPH and not for prostate cancer; however, a man can have BPH and prostate cancer at the same time. Doctors usually recommend that men be checked for prostate cancer once a year when they turn 50 (or 40 if a family member has had prostate cancer). A higher incidence of prostate cancer has been noted in men of African-American descent. These checks should continue even if you are taking CARDURA.®

How To Take CARDURA® and What You Should Know While Taking CARDURA® for BPH

CARDURA® Can Cause a Sudden Drop in Blood Pressure After the VERY FIRST DOSE. You may feel dizzy, faint or "light-headed," especially after you stand up from a lying or sitting position. This is more likely to occur after you've taken the first few doses or if you increase your dose, but can occur at any time while you are taking the drug. It can also occur if you stop taking the drug and then restart treatment. If you feel very dizzy, faint or "light-headed" you should contact your doctor. Your doctor will discuss with you how often you need to visit and how often your blood pressure should be checked.

Your blood pressure should be checked when you start taking CARDURA® even if you do not have high blood pressure (hypertension). Your doctor will discuss with you the details of how blood pressure is measured.

Blood Pressure Measurement: Whatever equipment is used, it is usual for your blood pressure to be measured in the following way: measure your blood pressure after lying quietly on your back for five minutes. Then, after standing for two minutes measure your blood pressure again. Your doctor will discuss with you what other times during the day your blood pressure should be taken, such as two to six hours after a dose, before bedtime or after waking up in the morning. Note that moderate to high-intensity exercise can, over a period of time, lower your average blood pressure.

You can take CARDURA® either in the morning or at bedtime and it will be equally effective. If you take CARDURA® at bedtime but need to get up from bed to go to the bathroom, get up slowly and cautiously until you are sure how the medication affects you. It is important to get up slowly from a chair or bed at any time until you learn how you react to CARDURA.® You should not drive or do any hazardous tasks until you are used to the effects of the medication. If you begin to feel dizzy, sit or lie down until you feel better.

- You will start with a 1 mg dose of CARDURA® once daily. Then the once daily dose will be increased as your body gets used to the effects of the medication. Follow your doctor's instructions about how to take CARDURA.® You must take it every day at the dose prescribed. Talk with your doctor if you don't take it for a few days for some reason; you may then need to restart the medication at a 1 mg dose, increase your dose gradually and again be cautious about possible dizziness. Do not share CARDURA® with anyone else; it was prescribed only for you.
- Other side effects you could have while taking CARDURA,® in addition to lowering of the blood pressure, include dizziness, fatigue (tiredness), swelling of the feet and shortness of breath. Most side effects are mild. However, you should discuss any unexpected effects you notice with your doctor.
- Keep CARDURA® and all medicines out of the reach of children.

FOR MORE INFORMATION ABOUT CARDURA® AND BPH TALK WITH YOUR DOCTOR, NURSE, PHARMACIST OR OTHER HEALTH CARE PROVIDER.

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THE OCEANS

Coral Hot Zone

WHITE POX IS the name scientists have given to a newly discovered disease that is attacking coral reefs near Key West, Florida. Nobody knows what is causing the pox, or how to stop it. If it spreads unchecked, it could ruin the famed reefs of the Keys, and perhaps damage the entire marine ecosystem of the region.

A disease called White Pox is killing elkhorn coral growing in Florida Keys (above). In a phot taken 15 months later, most o coral in the area has died (bel

"In disease terms, this is a hot zone," says James Porter, a marine biologist at the University of Georgia who studies coral reefs. "In some areas, it has killed between 50 and 80 percent of the elkhorn coral, which is the dominant coral in the area," he says.

DR. JIM PORTER/UNIVERSITY OF GEORGIA (2)

White Pox manifests itself as discolored blotches from the base to the tip of the coral. In the advanced stages of the disease, the living tissue of the coral disintegrates and falls away, exposing the underlying white skeleton.

"Corals are the [miners'] canaries of the coral reef," says Porter. "But they are a lot more important than canaries. They provide the primary structure of the reefs that are home to fishes and the myriad invertebrates that colonize the reef. If the corals die, the reefs as we know them will die too."—*A.F.*

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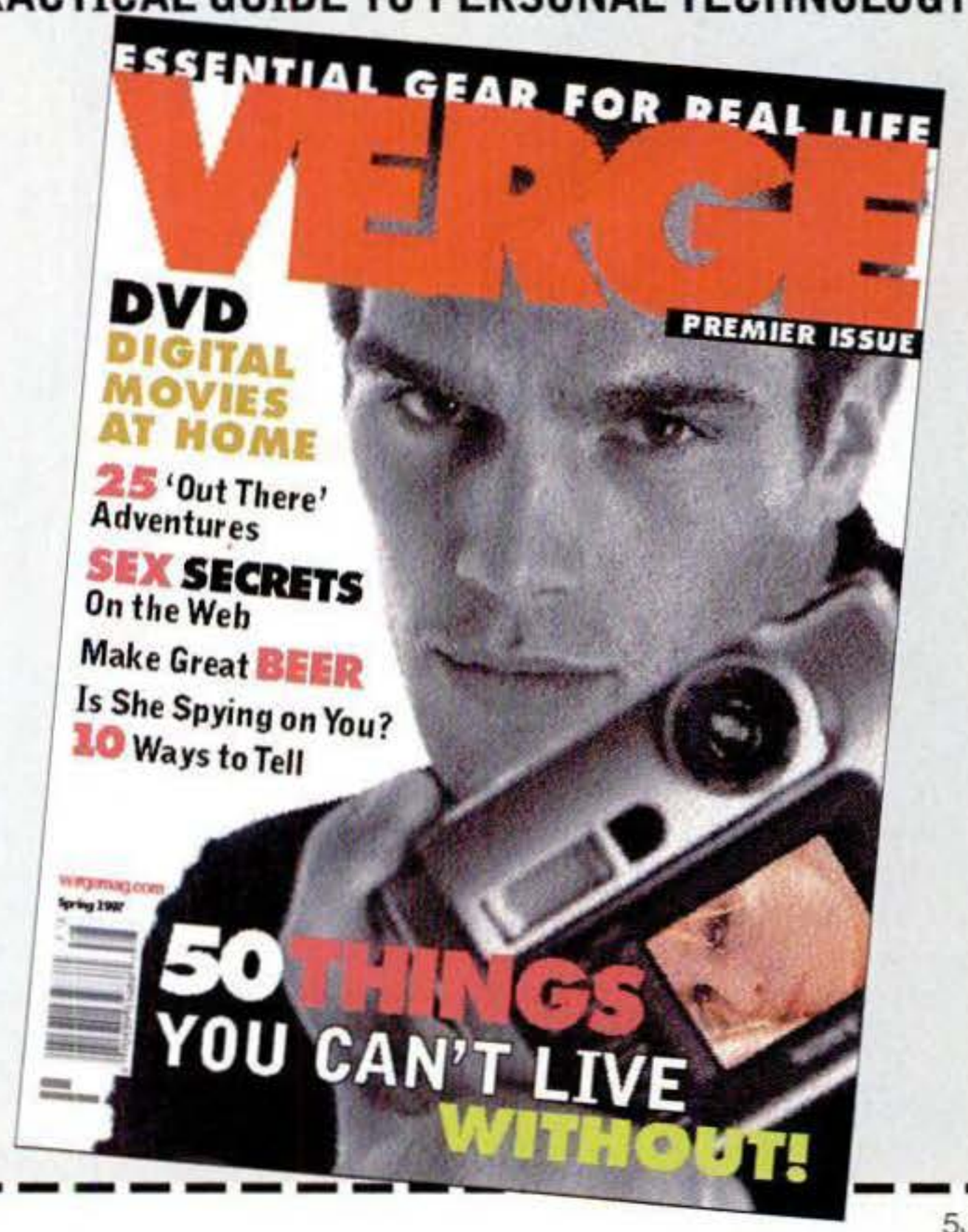

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AVIATION

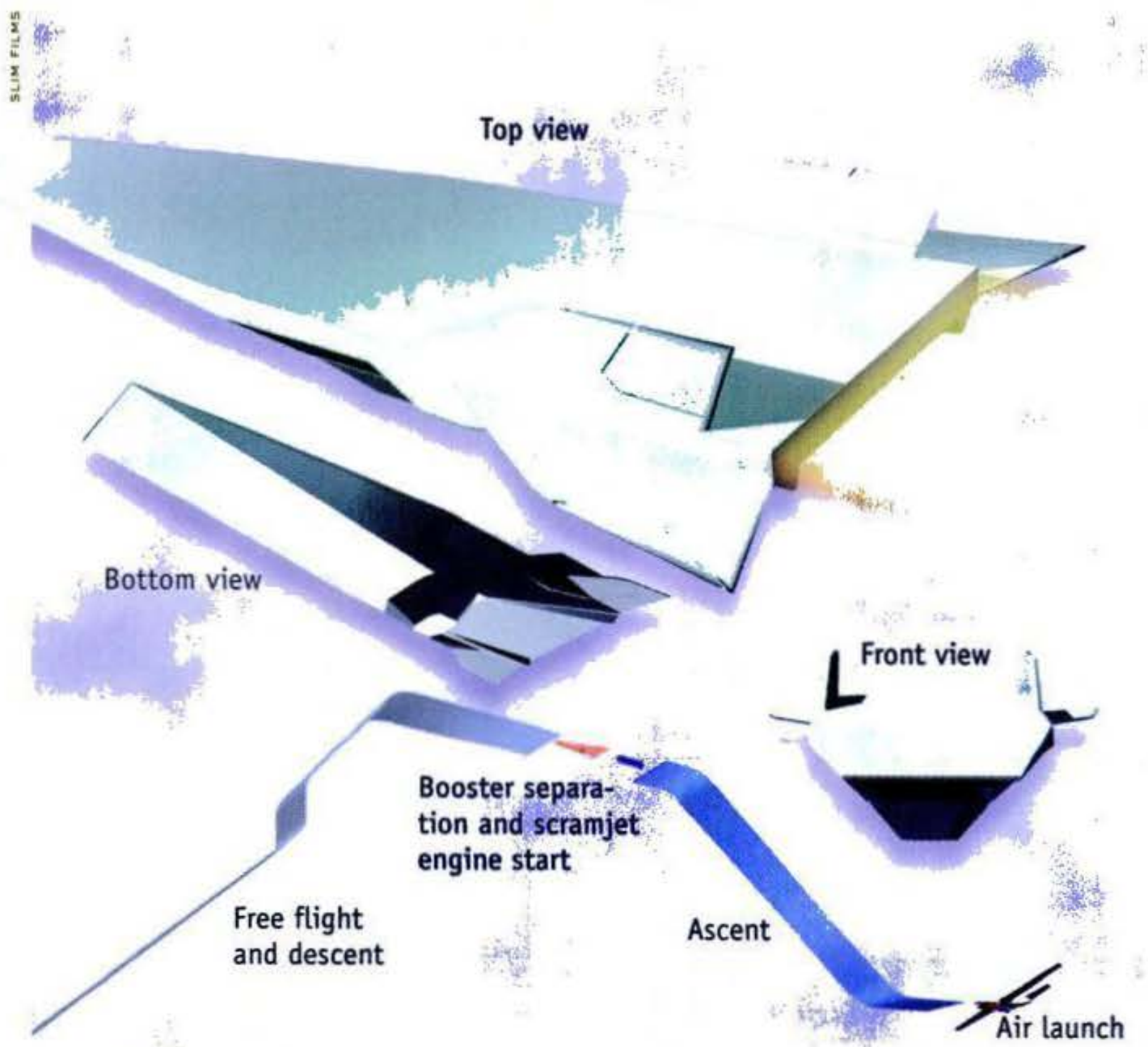
Going Hypersonic

NASA HAS BIG plans for a small vehicle that will fly at hypersonic speeds of Mach 5—3,600 mph—and faster. Called Hyper-X, the 12-foot-long unpiloted prototype aircraft is designed to test a ramjet-scramjet propulsion system of the type that engineers studied in the X-30 national aerospace plane program during the late 1980s.

A ramjet is a simple engine that functions only at speeds above Mach 1. In its scramjet mode, above Mach 5, the engine must combust hydrogen fuel and air roaring through it at supersonic speed. The air-breathing powerplant has the potential to give an ultrafast aircraft greater payload capacity than rocket planes like NASA's record-setting X-15, which flew at a speed of Mach 6.7.

NASA recently awarded a $150 million contract to build a fleet of four Hyper-X test vehicles. The first is scheduled to be carried aloft next year on the first stage of a Pegasus rocket, which will be launched off the California coast from a B-52 bomber. The Pegasus booster will accelerate the Hyper-X to speeds from Mach 5 to Mach 10, whereupon it will separate and fly under its own power. Three more flight tests will follow.

NASA has already done more than 1,000 wind-tunnel tests of the Hyper-X shape. The goal of the flight tests is to validate the wind-tunnel data and to demonstrate—for the first time—a scramjet integrated with an aircraft, not just on a test stand. Proving that a scramjet-powered aircraft works at Mach 10 could pave the way for even faster test birds.—*S.F.B.*



In flight tests planned for next year, a B-52 bomber will release a Pegasus rocket (blue) over water at an altitude of 40,000 feet. The rocket will ascend to 100,000 feet, accelerating the Hyper-X aircraft (red) to a speed of Mach 5 or greater before releasing it. The scramjet engine on Hyper-X will then start, and the aircraft will fly under its own power, performing speed-reducing maneuvers during its descent.

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AUTOMOTIVE

EDITED BY DAN McCOSH

BRAKES

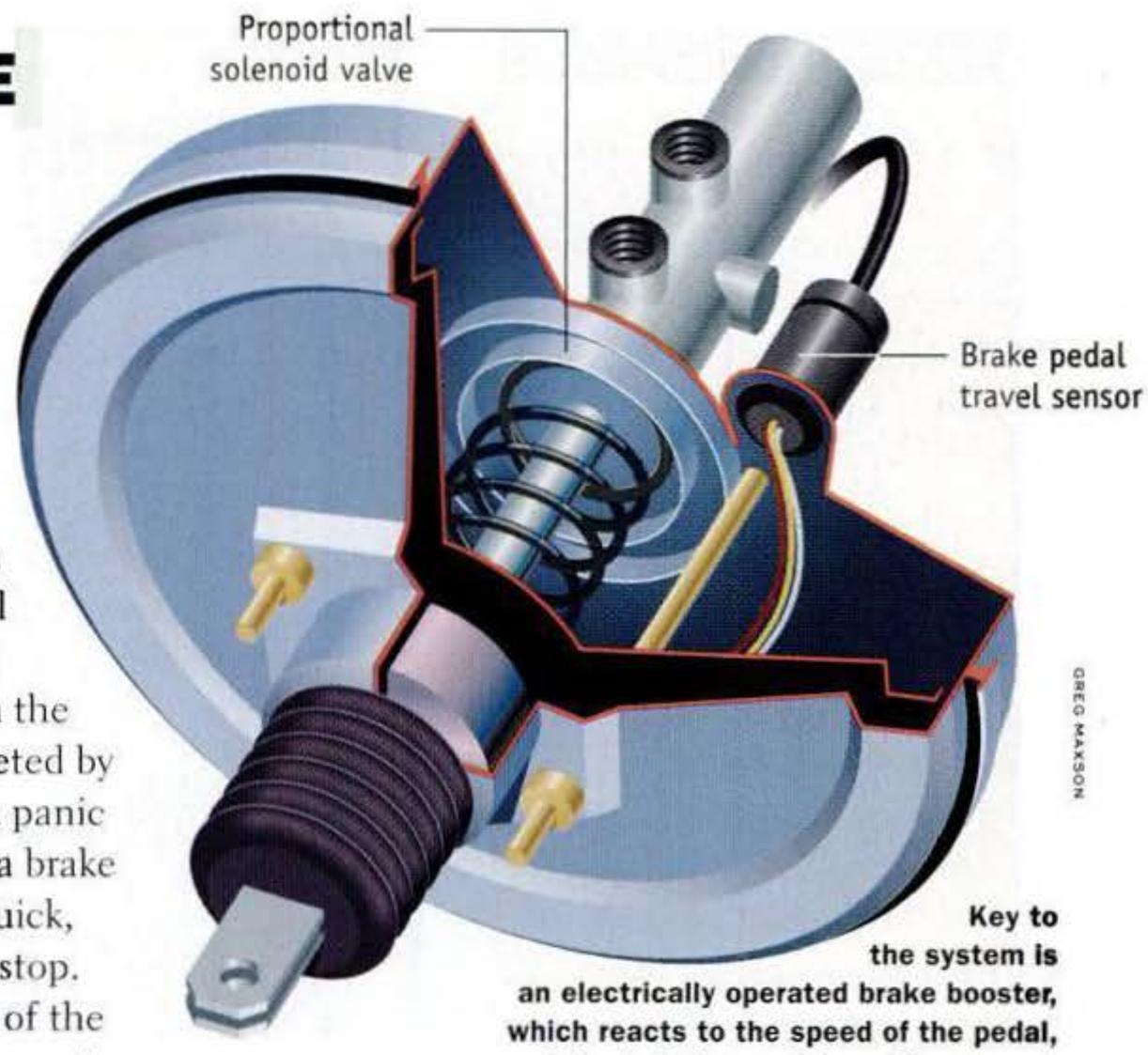
A Fix for ABS

A STUDY IN Germany of motorists in panic braking situations indicates that they don't seem to panic. That is, they don't necessarily slam on the brakes, even when a solid barrier that they will probably hit pops up in front of them.

ABS brakes produce their shortest stopping distances when the brake is slammed on hard, allowing the electronics to go to work, holding the brake at the threshold of traction. The study reveals, however, that the tendency for most motorists is to stab the brakes, then back off, which makes for longer stopping distances.

Now an electronic system attempts to give the driver a hand. The system, developed by the Lucas Varity Corp., senses the speed at which the brake pedal is depressed. A sudden stab on the brakes, interpreted by the system as a panic stop, activates a brake booster for a quick, hard, full ABS stop.

Proponents of the system say it can cut significant distance from a non-assisted stop in an accident-avoidance situation. Yet the system works subtly; our test drive showed that noticing it at work is difficult. It doesn't activate on slippery surfaces, where even light pedal pressure produces a full ABS stop. On a drier surface, it activates only when specific parameters are met. In most cases, it is undetectable to the driver, with an indicator light the only sign that it is working properly.—*D.M.*



GREG MAXSON

Key to the system is an electrically operated brake booster, which reacts to the speed of the pedal, detected via a pedal position sensor.

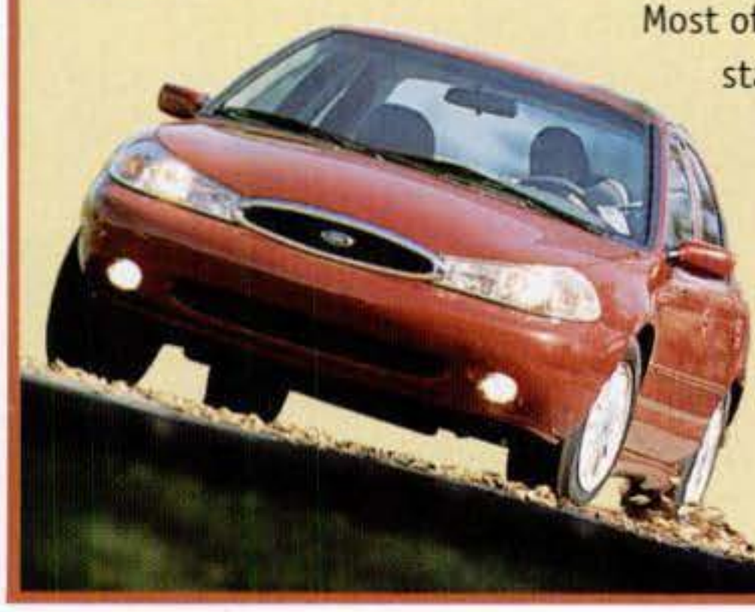
PREVIEW DRIVE

Fast-Forward Contour

WITH 170 HORSEPOWER, Ford's Contour SE V6 is one of the quickest small sedans around, but it has never quite achieved the recognition accorded the Chrysler Neon, or Acura's Integra GS-R. But with 195 horsepower, augmented by suspension and brake upgrades, the new Contour SVT will be hard to ignore.

SVT stands for Special Vehicle Team, the limited-edition group that creates go-faster editions of Ford's mainstream vehicles. The SVT uses a variety of techno tricks to coax an additional 25 hp from the Contour's 2.5-liter V6.

Most of these tricks are standard practice on hot rods. But the key element is the extrude-hone process, which forces a mushy, puttylike compound laden with fine grit through castings such as the intake ports and runners to achieve a smoother inner surface and thus better flow. The SVT Contour project engineers estimate that extrude-honing accounts for about two-thirds of the power boost.



The SVT Contour adds horsepower to Ford's sporty compact sedan.

On the track, the extra horsepower hustles the SVT around with gratifying zeal. Although the SVT version of the Duratec V6 is tuned for top-end performance—peak torque remains unchanged at a modest 156 foot-pounds—it's capable of pushing the car to 60 mph in just over seven seconds and a top speed of 143 mph. Like the regular Contour and Mercury Mystique, its fundamental handling trait is understeer, but it's considerably closer to neutral.

Ford showed remarkable restraint with the SVT's appearance, adding only rocker-panel extensions and a front air dam to the Contour's new front fascia. Inside, the SVT adds dark blue leather upholstery and black-on-white analog instrumentation to the basic interior.

You do pay a price for added zip. At $22,900, the SVT Contour is considerably more expensive than the recently facelifted Contour SE and Mystique LS, both of which start at around $16,000.—*Tony Swan*

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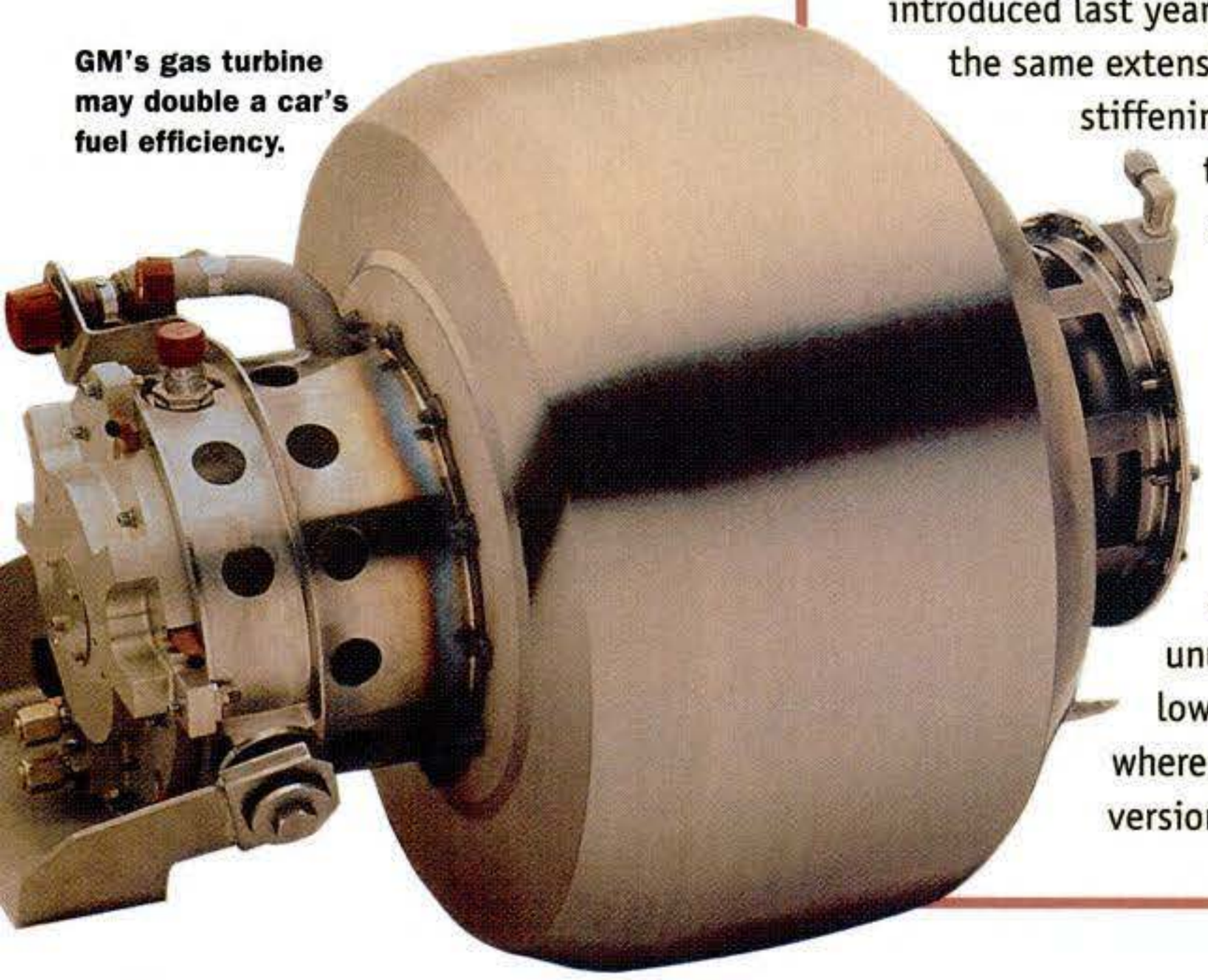
ELECTRIC CARS

GM's Turbine Backup

GENERAL MOTORS and Williams International, a defense supplier whose wares include turbine engines for cruise missiles, have developed a new hybrid auxiliary propulsion unit (APU) that's said to be the smallest, lightest, and most fuel-efficient turbine APU of its kind ever built.

When used in an advanced electric vehicle, the gas turbine would power a generator for charging an EV's onboard batteries and extending driving range. GM claims the turbine APU could more than double the fuel economy of a vehicle. Among the turbine APU's technical advances is an integral heat-recovery unit that reduces noise and increases efficiency, and a compact SatCon Technology power controller that's demonstrated a 98 percent generating efficiency in the lab.

The GM turbine hybrid project isn't narrowly aligned to a particular fuel of choice. Rather, the goal is to work toward bringing a promising technology to the fore while allowing fuels to sort themselves out in the marketplace. GM is reportedly planning to demonstrate the principal by building a hybrid prototype with a turbine APU that will debut this year.—*Ron Cogan*



GM's gas turbine may double a car's fuel efficiency.

PREVIEW DRIVE

A Sporty Escort?

ALTHOUGH ITS performance doesn't quite measure up to its snappy sheet metal, Ford's Escort ZX2 coupe has all the other elements of a winner.

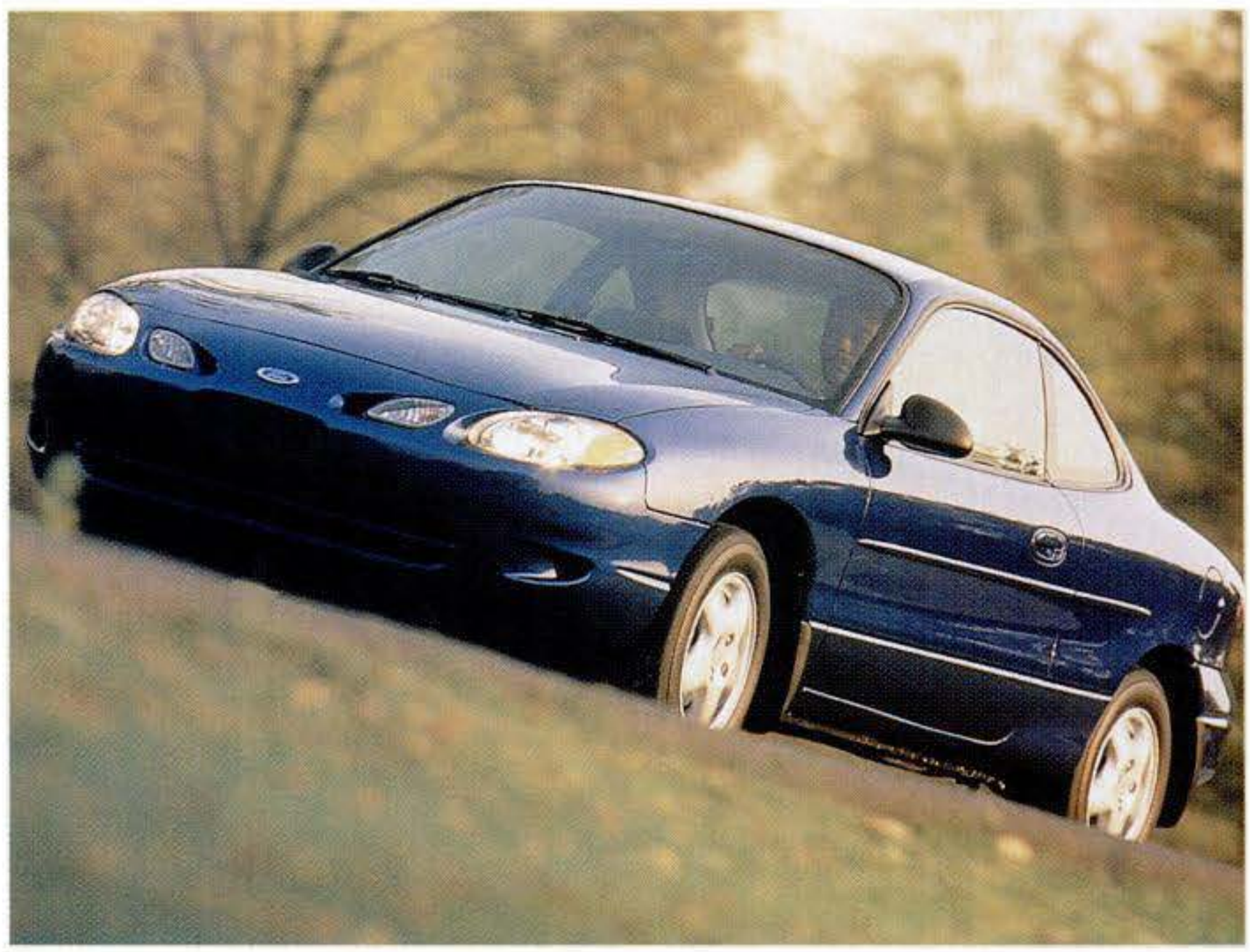
The newest member of the compact Escort lineup, the ZX2 offers a pleasant ride, above-average steering precision, competent handling, and attractive interior appointments—including a usable back seat. The basic floorplan is essentially the same as the re-engineered sedan and wagon introduced last year, incorporating the same extensive chassis-stiffening features that translate into more precise handling, and the same chassis dimensions.

However, the ZX2's body panels are all new, which is unusual among low-cost coupes, where the two-door version frequently is the low-cost, base model developed primarily from the sedan components.

Its suspension has been tweaked for a sportier feel, and it departs from the rest of the Escort line by using a more powerful, and larger, powerplant that isn't available in the sedans. That engine, the 2.0-liter, Zetec dual-overhead cam, 16-valve model with 4 cylinders, is standard in the midsize Ford Contour and Mercury Mystique.

The additional power comes from a new exhaust-side variable-cam timing system that raises the Zetec's output to 130 horsepower, in contrast to the 110 hp of the Escort sedan. That still falls a bit short of the sizzle offered by Chrysler's little Neon coupes, but it's respectable among the rest of the small coupe class. And this Escort is mannerly as well.

The ZX2 will be offered in one trim level, well-equipped, starting at about $13,000. A sport package will be available, with aluminum alloy wheels and rear decklid spoiler, but, alas, no performance upgrades. The new coupe will be at Ford dealers only; the Mercury Tracer version never made it out of the planning stages.—*T.S.*



All-new body panels distinguish Ford's ZX2 coupe from most competitors.

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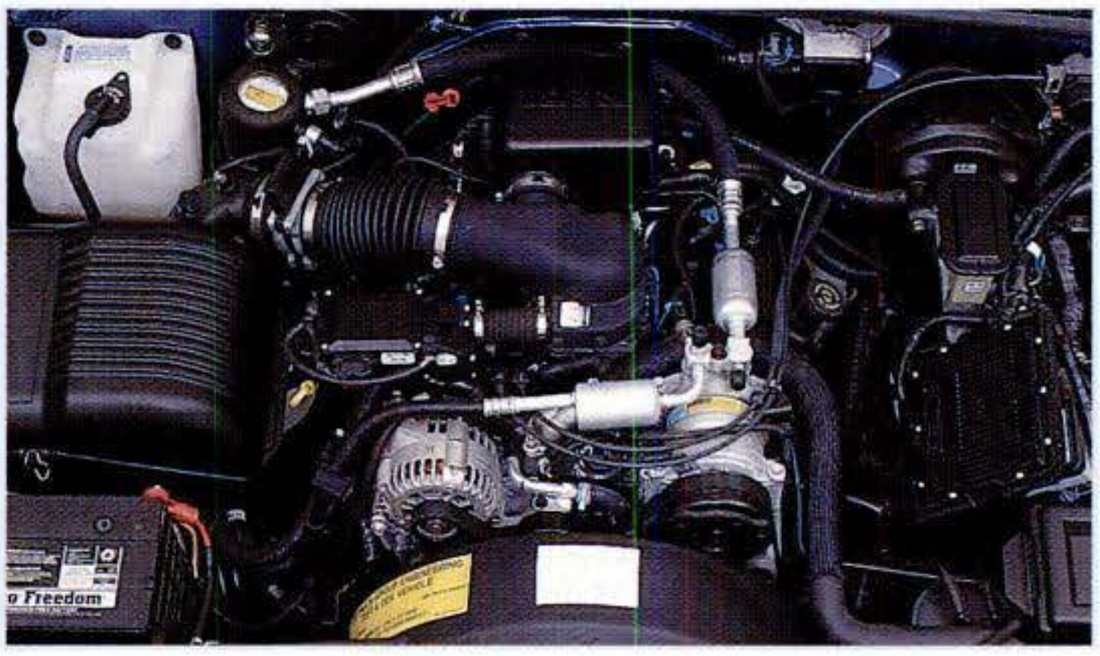
ALTERNATIVE FUELS

GM Goes Natural

IF AT FIRST you don't succeed with natural gas...try again. That's what General Motors is doing with a new bi-fuel, 3/4-ton pickup. GM took an earlier compressed natural gas (CNG) pickup off the market after a series of problems with its high-pressure storage tanks that led to failures and a quick recall. But unlike those 1992 and 1993 pickup models, which ran only on compressed natural gas, these 1997 Chevrolet C2500 and GMC Sierra "factory package" models run on either CNG or gasoline.

The new pickups' V8 is modified for bi-fuel operation. Excellent driving range is provided by a standard 34-gallon gasoline tank and a carbon-fiber overwrapped steel CNG cylinder that holds the equivalent of 13 gallons of gasoline. The system automatically switches to gasoline when the gaseous fuel is depleted.



GM's new CNG pickups can run on either natural gas or gasoline.

The bi-fuel option adds $5,800 to the price of a standard GM pickup, but this cost is at least partly offset by a federal tax credit and possibly other state and local purchase incentives.

GM is not alone. Ford offers a number of CNG models, including the F-Series pickup, Econoline van, and Contour sedan. Honda will be selling its natural gas Civic GX shortly. And GM itself is in the process of adding a bi-fuel option to the Chevy Cavalier and other derivatives of the J-car platform.—*R.C.*

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ELECTRONICS

EDITED BY FRANK VIZARD

HANDS ON

Online TV Guide

FRUSTRATED BY the paucity of information accompanying most TV listings? Want to create your own weekly viewing guide? A new service called Program Master may be for you.

Downloaded TV listings are transferred to a remote control that works with your TV or VCR.

Program Master uses your PC to manage TV viewing. Developed by Scottsdale Technologies in Scottsdale, Arizona, Program Master includes software that links you to Electronic TV Host, an online database that, for $50 a year, provides you with 10-day programming schedules for broadcast, cable, and satellite services in the top 100 U.S. television markets. It also includes a mouse-like infrared repeater that stores program data received from the PC. This line-of-sight repeater then prompts your TV, satellite dish, VCR, or cable box to tune in or record at scheduled times, using infrared remote control codes, which are downloaded from the database as well.

The software, which dials a local phone number, lets any number of people create personal viewing schedules, and you can search the online database by program title, genre, channel—even by performer. The software can be programmed to conduct similar searches with each log-on—to keep watch for a specific movie or actor, for example. And unlike electronic guides that are transmitted directly to a TV or VCR, Program Master can use the PC's much larger memory to store comprehensive program descriptions. Once you've decided on a 10-day viewing schedule, the software can print out a custom program guide—including feature copy and a crossword puzzle—geared toward your viewing tastes.

The initial Program Master package of hardware and software costs $50 and includes a six-month subscription to Electronic TV Host. You need an additional package for each TV you want to use with the service. Program Master can be especially handy if you've got a first-generation DBS satellite receiver, which usually can't be programmed to tell a VCR to start recording. Program Master is a far less costly solution than a new VCR or satellite dish, and it can schedule more events than a VCR.—*Stephen A. Booth*

SATELLITE TV

A 500-Channel Deal

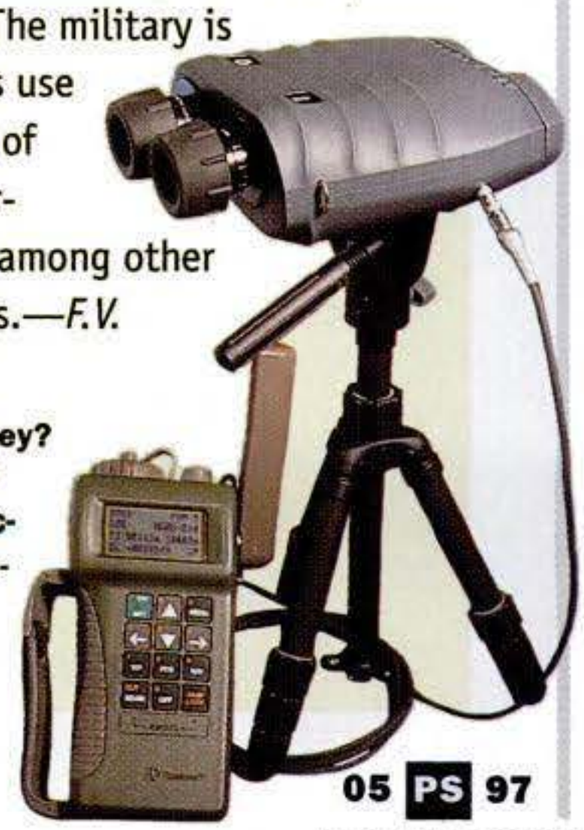
SEVEN SATELLITES providing 500 television channels—that's the vision that emerged from the announced merger of two satellite TV operations. The deal would combine the satellite TV services of Echostar and the SkyTV system operated by Rupert Murdoch's News Corp.

Murdoch intends to invest $1 billion in the operation. The vast channel capacity available would allow for the transmission of local broadcasting stations not now available. Local stations should be available to about 75 percent of the nation's viewers by the end of next year.—*F.V.*

GPS

Digital Recon

WHAT HAPPENS when you marry an electronic binocular to a Global Positioning System receiver? The answer is a breakthrough in reconnaissance and surveillance. Combining the two technologies yields precise targeting, as demonstrated by a prototype unit developed by Leica Technologies of Leesburg, Virginia. The laser range finder inside the binocular reveals the distance to the object being viewed. This data is relayed to the GPS receiver. From there, the math is relatively simple: The GPS receiver calculates the distance from it to the target, producing a set of coordinates. The military is studying its use as a means of directing artillery fire, among other possibilities.—*F.V.*



Where are they? GPS receiver linked to electronic binocular knows.

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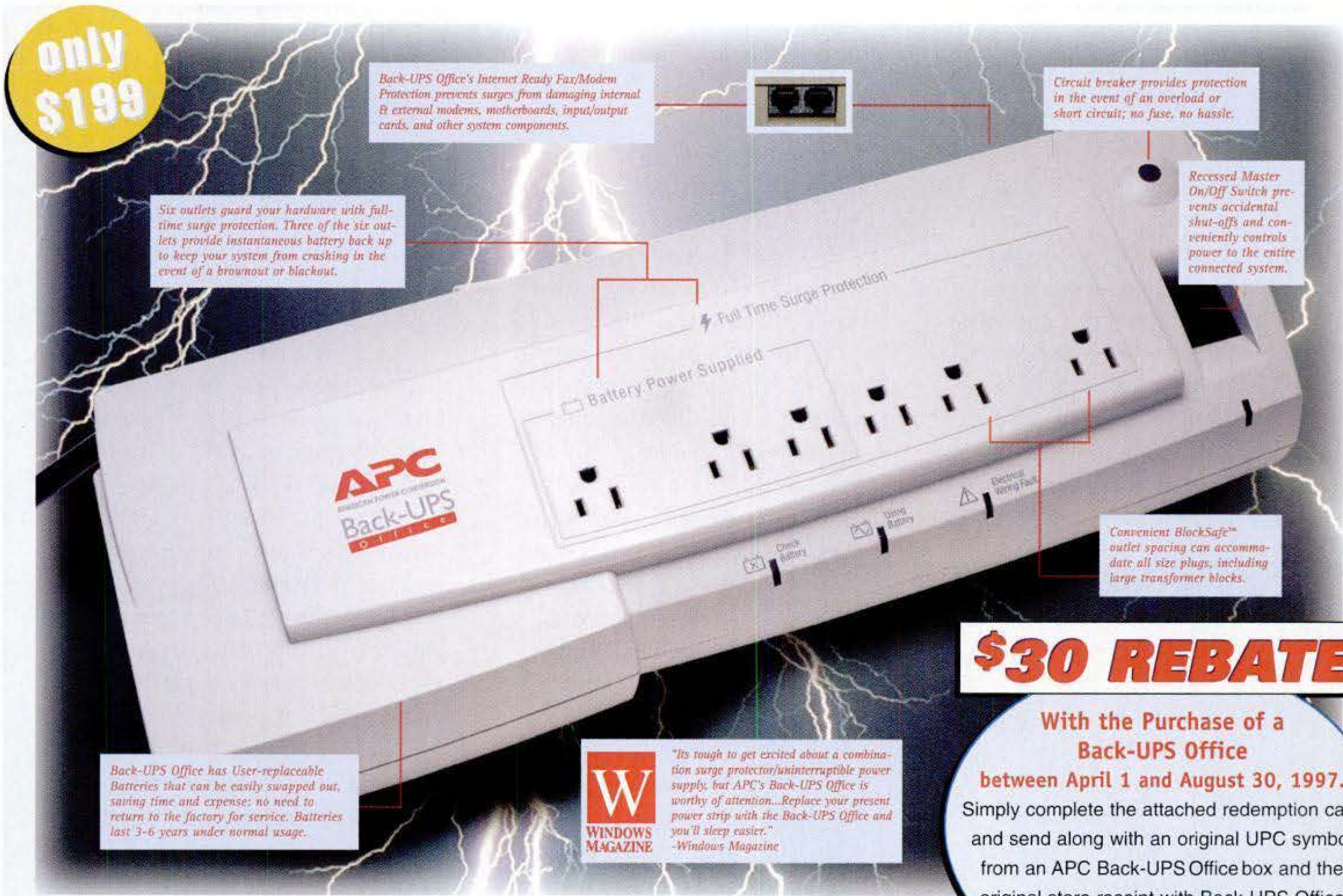
"They thought my new multipath Back-UPS® Office™ was just a big surge suppressor – then the lights went out."



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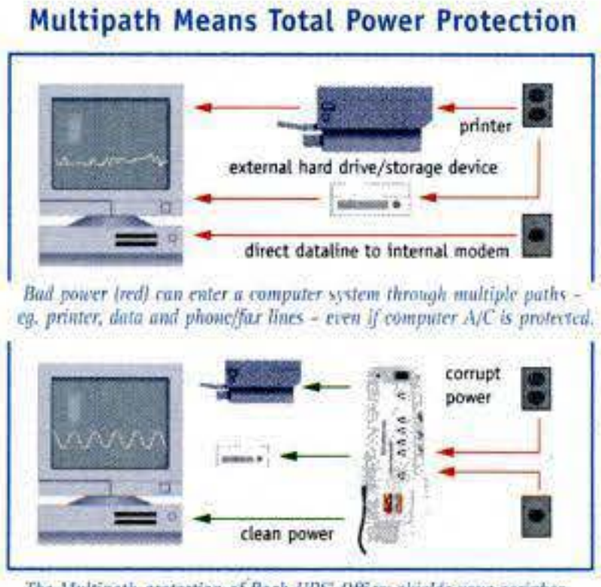

Bad power (red) can enter a computer system through multiple paths – eg. printer, data and phone/fax lines – even if computer A/C is protected.

The Multipath protection of Back-UPS® Office shields your peripherals and guards your computer from bad power on every path, providing clean, safe power (green), to your entire system.

Unique multipath protection keeps your PC and data safe

Plugging phone lines or other peripherals into your computer increases your vulnerability to power problems. When a surge hits an unprotected peripheral, it can blaze down serial cables and datalines, and toast your expensive PC. Multiple peripherals and datalines to and from your system are vital, but dangerous. Without them you can't do your job. If a power sag locks your keyboard or reboots your computer before you've saved work, or while you are downloading from the Internet, you can lose data, time and money. Don't spend another late night at the office to meet your deadline. Join over 6,000,000 computer users worldwide who prefer APC to protect hardware and data.

Back-UPS Office protects your entire system

Until now, protection for your entire system required several devices. Back-UPS Office means clean, safe power to every peripheral, and instant battery backup to keep your system from crashing. It means protection for less by integrating the security of a surge suppressor with the power of a UPS, guaranteed up to $25,000.

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PHOTOGRAPHY

Lower Prices for Digital Cameras

WAITING FOR digital camera prices to drop? Models in the $300 price range will arrive this year, thanks to an alternative imaging technology that reduces manufacturing costs.

The new electronic still cameras will have what's known as a CMOS (complementary metal-oxide semiconductor) active-pixel array instead of the CCD (charge-coupled device) image sensor used in current digital cameras. The first company to demonstrate the technology is Sound Vision of Framingham, Massachusetts. Vivitar says it plans to introduce a CMOS model this spring as well. Others will follow.

A CMOS image sensor will make digital cameras less expensive.

Sound Vision founder Bob Caspe notes that CMOS technology is not inherently superior to CCD, but says its "markedly lower" cost enables manufacturers either to build cameras less expensively, or to offer models with high resolutions and extra features at prices comparable to today's $500 to $700 CCD cameras. In addition to recording digital stills, Sound Vision's simply named Digital Camera can also function as a continuous input source for PC videoconferencing, transmitting one frame per second (fps) over regular phone lines. And while most CCD cameras express picture resolutions in PC configurations, such as 640 by 480 pixels, CMOS cameras use the 8-by-10 scale of photo prints. Images from Sound Vision's 800- by 1,000-pixel resolution CMOS camera have a letterboxed appearance onscreen, but nearly fill an 8.5- by 11-inch sheet of paper when printed from a PC.

The Sound Vision camera also differs from current CCD models in that it does not use the JPEG format to compress images for storage. Instead, Sound Vision employs "wavelet" compression licensed from Aware Inc. in Framingham, Massachusetts. According to Caspe, this can improve image quality by a factor of two over JPEG stills of equal compression. Vivitar says its CMOS-based Vivi-Cam 3000 will use JPEG, however.

Sound Vision's Digital Camera stores 75 to 1,200 images on removable PC cards, which supplement its built-in 2.5MB memory. The camera can record five seconds of audio per still, and even record motion video clips at 4 fps. The clamshell-style digital snapshooter is compatible with Windows and Mac computers. It has a fixed focus lens, optical viewfinder, and automatic flash; it runs on six AA alkaline batteries. Incidentally, CMOS sensors generally require less power than CCD devices, so you can expect a CMOS camera to run longer.—*S.A.B.*

VIDEO

Digital VHS Dawning

VCRs CAPABLE OF recording digital signals from direct-broadcast satellites and other digital sources should arrive this fall. So says JVC, which developed the original VHS format and is licensing the new Digital VHS (D-VHS) format.

The D-VHS format promises five to seven hours of recording time on a tape similar to today's two-hour VHS cassette. It also will record conventional analog telecasts (though at the time limits of VHS cassettes) and play previously recorded VHS tapes.

Digital VHS has been a long time coming. JVC first announced the concept in the spring of 1995, when digital direct-broadcast satellite (DBS) systems such as DSS, Primestar, and EchoStar were still in their infancy. Now, with DSS receivers in about three million U.S. households, and cable TV seemingly on the verge of delivering digital signals, VCR makers contend there is a sufficient base of potential users to make D-VHS worthwhile to produce.

One not-so-small proviso, though: You'll need a new DBS receiver in order to record on a D-VHS machine.That's because a D-VHS unit is basically a dumb machine—a so-called bit stream recorder. It can be used to record any digital information, including computer data. (The tapes have about 32 to 45 gigabytes of capacity, giving D-VHS the potential to be a household "server" feeding other computers.) To handle a specific format, though, such as the proprietary DSS signal or the world-standard MPEG-2/DVB transmission used by EchoStar, D-VHS requires an interface that allows playback decoding through the specific machine—*S.A.B.*

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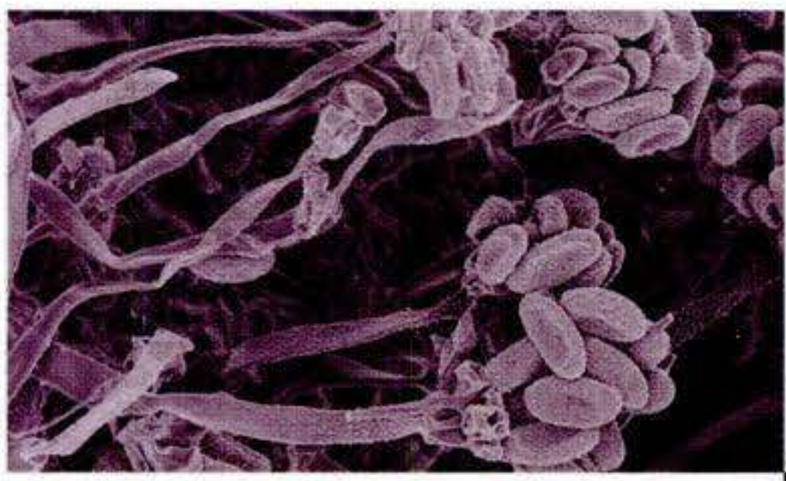
HOME TECHNOLOGY

EDITED BY JUDITH ANNE GUNTHER

HOME & HEALTH

The Edifice Complex

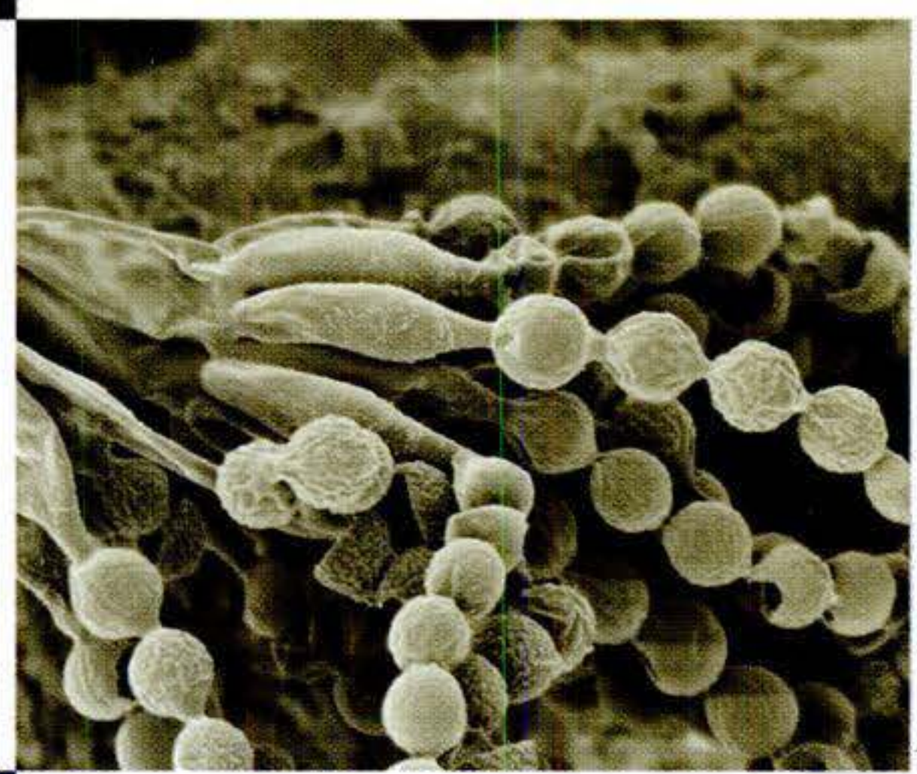
FOR YEARS, scientists have suspected that substances in indoor air can trigger cold- or flu-like symptoms in humans. Research has blamed this "sick building syndrome" on everything from carpets to insects. Georgia researchers are now pointing a finger at another culprit: mold, which they say can release toxic substances called volatile organic compounds (VOCs) into the air.



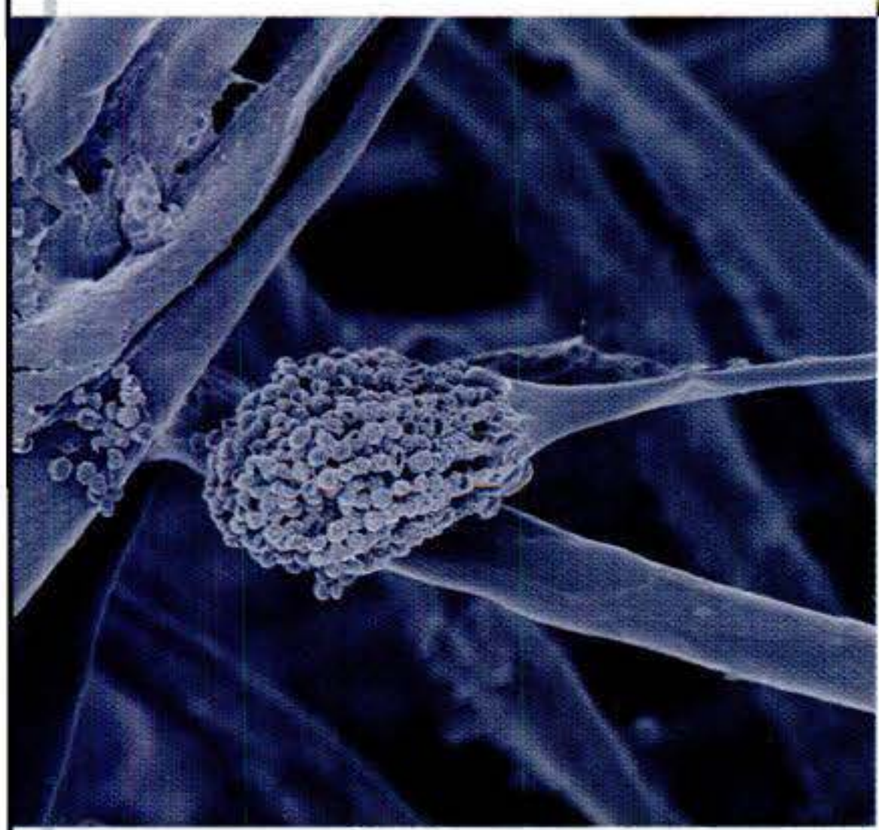
***Stachybotrys chartarum* grows on wallpaper.**

More than four years ago, Sidney Crow of Georgia State University and his colleagues examined 75 homes and other buildings in the Southeast to ferret out the causes of sick building syndrome. Although mold was a prime suspect, the researchers found that certifiably "sick" buildings (in which at least 20 percent of occupants have symptoms) didn't necessarily have more mold than healthy ones. They did notice, however, that many of the "sick" structures stank—so the researchers began testing the air for odorous chemicals.

Their investigation turned up VOCs known to irritate the eyes and nose and VOCs that suppress the immune system, leaving people vulnerable to colds and other ailments. Lab tests of moldy samples from the buildings showed the microbes emit VOCs as waste products in certain environments. To clinch his case, Crow is now trying to link specific ailments to the VOC mixtures he found in buildings and to determine what conditions prompt mold to make VOCs.



Also on wallpaper: the fungus *Penicillium*.



***Aspergillus* fungus residing on an air filter.**

The best way keep mold at bay is to prevent its growth in heating and air-conditioning systems by cleaning filters frequently. Crow also recommends having systems inspected regularly. "Systems that are properly designed and maintained rarely have a problem," says Crow.—*Ingrid Wickelgren*

ENERGY

Fuel Cells for Home

FUEL CELLS MAY be in the headlines for their appearance in vehicles like Mercedes-Benz's NECAR II, but the energy-storage devices might find a place at home, too. ElectroChem Inc., a company in Woburn, Massachusetts, is exploring ways to pair a fuel cell with solar cells for homegrown power.

During the day, photovoltaic panels on a house's roof would convert sunlight into electricity. Some of that power could be consumed immediately; the rest would be shunted to an electrolyzer unit, a device that breaks down water into hydrogen and oxygen.

After sunset, the stored gases could then be used by a proton-exchange membrane fuel cell. This fuel cell uses a chemical reaction—the oxidation of hydrogen—to produce a current. Because the fuel cell's waste product is water vapor (which can be used again by the electrolyzer unit), the system is virtually pollution-free.

That's an advantage over batteries, which require hazardous materials, like lead and sulfuric acid, to generate electricity.

According to ElectroChem senior scientist Steven Lis, a typical single-family house would require a two-kilowatt fuel cell and approximately 10 square meters of photovoltaic panels to satisfy its power needs. But while such a setup would eliminate a monthly utility bill, it does come with a price. Fuel cells today are far too expensive for most homeowners, says Lis. In the future, he says, ElectroChem hopes to reduce fuel cell prices to a range between $5,000 and $20,000 for a residential-size system.—*J.A.G.*

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ACE

Ace puts the red vest to the test

Do I need an antisiphon valve on my outdoor garden hose connection?

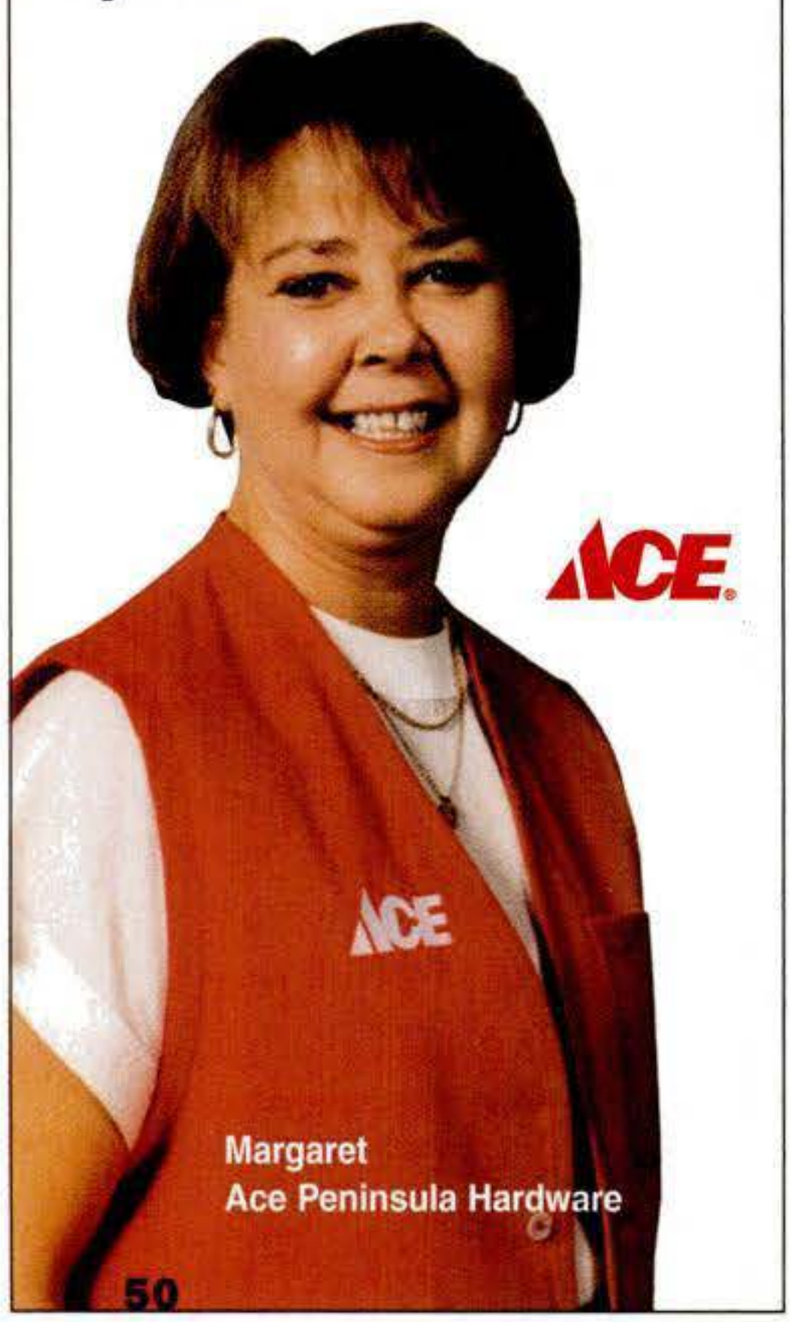
Some municipalities now require these devices on new or retrofit plumbing installations. It's a good idea to install them on outdoor hose outlets, where accidental backflow of garden fertilizers or insecticides could contaminate your home's fresh water system.

How can I make my outdoor power equipment more environmentally friendly?

Keep it tuned and clean your air filters often to reduce emissions. Use biodegradeable oil for two-cycle fuel, and canola-based bar oil for chain-saws. You might also consider switching to a battery-powered lawn mower and yard tools.

What can we use besides chemical fertilizers for our lawn and garden?

Commercial organic fertilizers are available. If you want to go "all natural," your options range from home-made compost to exotic nutrients like cultivated worm castings and lawn foods fortified with beneficial soil-building micro-organisms.



Margaret
Ace Peninsula Hardware

PLUMBING

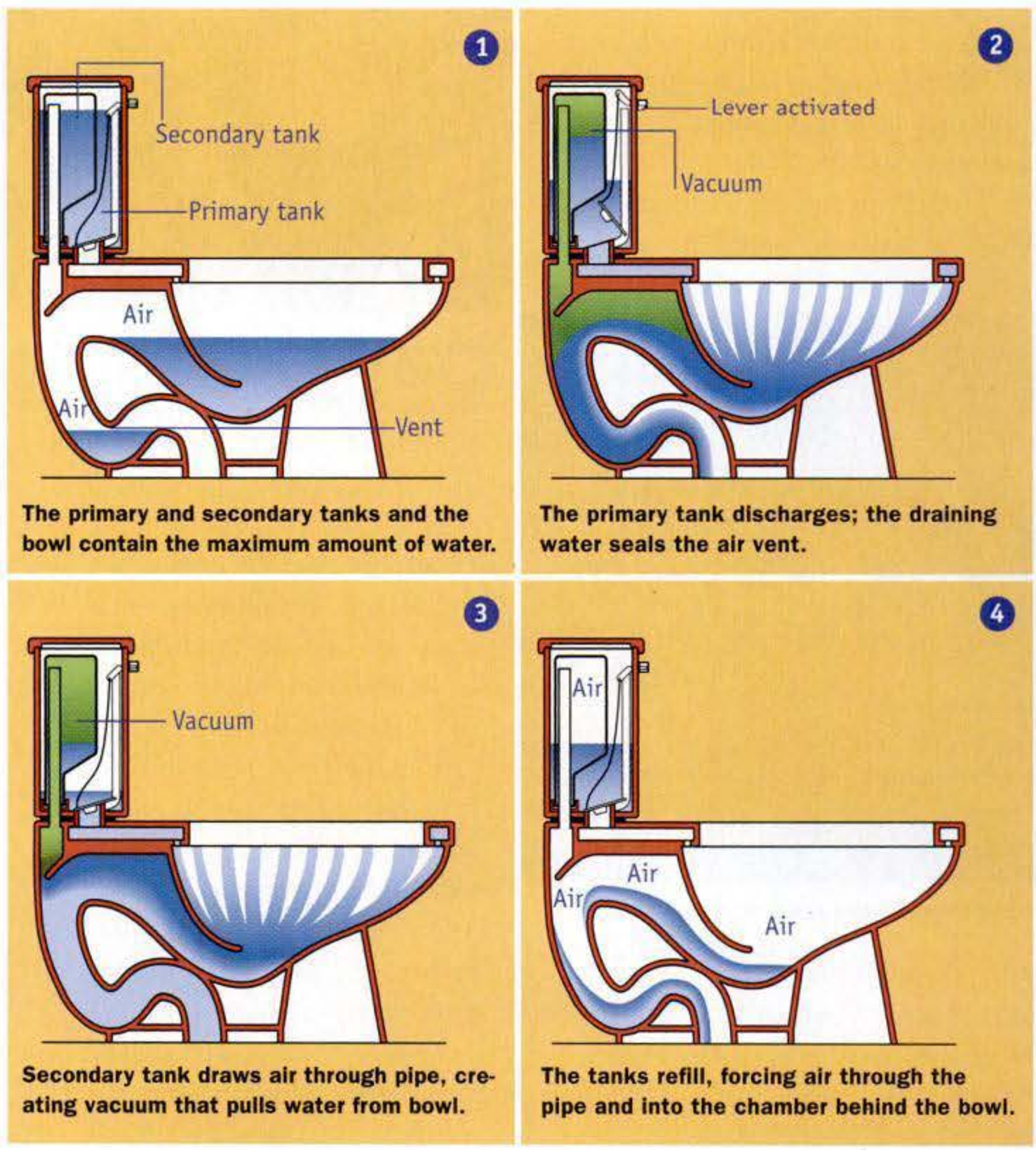
Super Bowls

TOILET MANUFACTURERS are working hard to clean up the reputation of water-saving commodes. In 1994, the federal government mandated that all residential toilet installations use water-saving models. But homeowners complained that by using 1.6 gallons of water per flush instead of the traditional 3.5 gallons, the toilets didn't have enough oomph to get the job done.

To make each push of the lever more effective, several manufacturers now offer air-assisted toilets. A bladder inside the tank holds compressed air, which helps propel the water into the bowl and down the drain. But air-assisted commodes are often noisy and cost about $200 more than other water-saving toilets. Another design, by Kohler, uses an electric pump to accelerate the water through the bowl. It's also effective, but this commode costs more than $1,000. Moreover, it requires a nearby electrical outlet.

The newest low-flush contender, the Vac system, takes a different approach: It creates a partial vacuum behind the bowl that boosts the flow rate of the draining water. Created by Fluidmaster, of Anaheim, California, this system uses a double tank design. At the beginning of the cycle, water in the first tank flows into the bowl and onward down the drain. As it flows, it seals a trap in the drain. Meanwhile, the second tank releases its water and pulls in air through a pipe connecting this tank to a chamber just behind the bowl. This creates a vacuum in the chamber, which helps draw water from the bowl more forcefully.

The first commode to include the Vac design is made by Briggs of Tampa, Florida, and sells for about $275.—*J.A.G.*



The primary and secondary tanks and the bowl contain the maximum amount of water.

The primary tank discharges; the draining water seals the air vent.

Secondary tank draws air through pipe, creating vacuum that pulls water from bowl.

The tanks refill, forcing air through the pipe and into the chamber behind the bowl.

GREG MAXSON

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Hiding in Plane Sight

Stealth aircraft own the night. Now they want the day.

By Steve Douglass & Bill Sweetman

LOCKHEED MARTIN'S F-117A Nighthawk stealth fighter was the star of the Gulf War, flying behind enemy lines to hit Baghdad targets with pinpoint accuracy. At night, the F-117 was unstoppable. But by day, the black jet stayed on the ground.

The F-117 isn't fast enough to outrun missiles or agile enough to dodge them, and it can't fight back because it's armed only with bombs. These limitations don't matter at night, because the F-117's stealthy shape enables the aircraft to avoid detection by enemy radar. But in the light of day, the enemy can see the black plane against the sky, and can take aim without the help of radar.

F-117 pilots train almost exclusively for night missions, and the darker it gets, the happier they are. But this is a compromise at best. In the summer, when there are only a few hours of darkness, a fighter like the F-117 can fly only one sortie per day. And the darkness that hides the F-117 also hides its targets.

Air Force generals would love nothing more than a stealth aircraft that would be invulnerable during daylight hours as well as at night. And as POPULAR SCIENCE

Disappearing Act

Future aircraft such as Lockheed Martin's proposed Joint Strike Fighter might use visual stealth to blend into the sky. Sensors would measure the sky's brightness and hue, and electrochromic coatings applied over a white skin would change shade to match the background.

ILLUSTRATION BY JOHN FRASSANITO & ASSOCIATES

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has learned, military engineers are already hard at work on the technologies needed to build such a plane. Special lights, coatings, and other technologies under investigation could not only make future fighters disappear from radar screens but could also make them almost completely invisible to the human eye. By the early 2000s, stealth may be practical in broad daylight.

Today's experiments exploit a principle that was demonstrated half a century ago, **in a secret project code-named Yehudi**. In that project, engineers mounted lights on an antisubmarine aircraft to make it harder to spot against a bright sky. Similar technology was used in the Vietnam War to shorten the distance at which the F-4 Phantom could be detected.

Lighting systems were available when Lockheed's Skunk Works was awarded the contract to build Have Blue, the world's first stealth aircraft and the testbed for the F-117A, in 1976. The breakthrough that made Have Blue possible was the ability to reduce an airplane's radar reflectivity to less than one-hundredth of what was considered normal in the 1960s, slashing the effective range of enemy radar. Reducing the radar reflectivity so radically meant that the designers of Have Blue also had to reduce its visual and infrared signatures, according to a rule of thumb known as "balanced observables."

This rule says that a stealth aircraft should be designed so that every detection system arrayed against it has roughly the same range. There is no point in building an airplane that is invisible to radar at five miles if optical sensors can see it at 10 miles.

Have Blue was the prototype for an aircraft that would make its attack run at a moderate altitude of 10,000 to 15,000 feet—close enough to designate the target accurately, but high enough to elude medium-caliber gunfire. At the time, the designers' goal was an aircraft that would be as stealthy in daylight as at night.

The designers realized that visual detection depends on a number of factors, including the position of the

Daytime Running Lights

TODAY'S EXPERIMENTS with visual stealth have their roots in a 1943 U.S. Navy project code-named Yehudi. The intent of the program, which was highly secret at the time and came to light only in the 1980s, was to give Navy patrol aircraft a better chance of sinking enemy submarines.

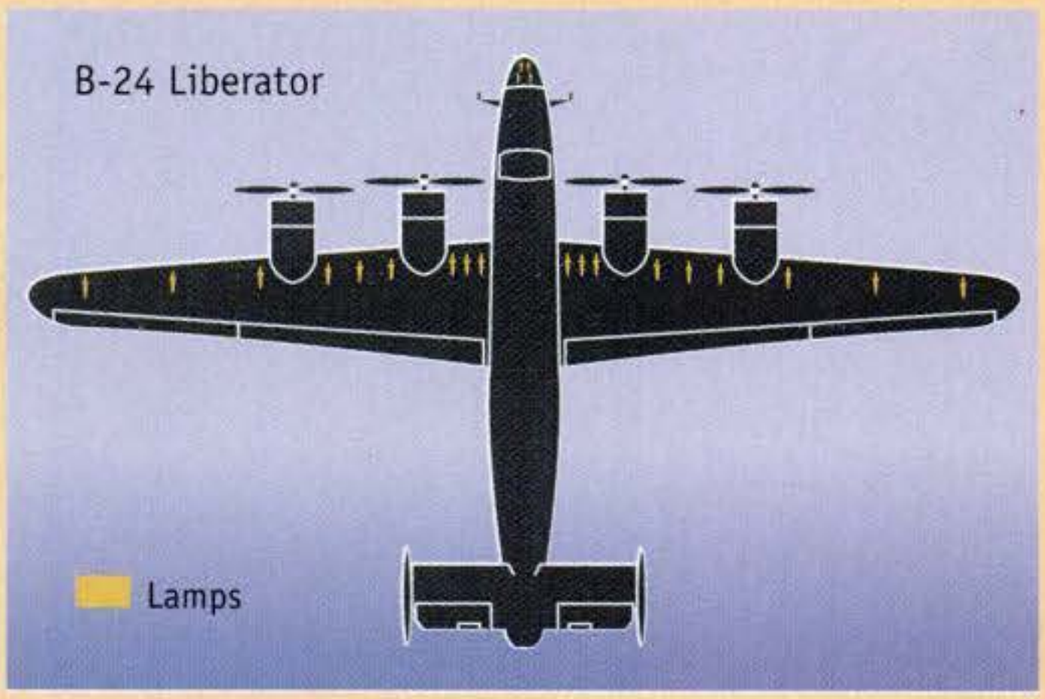
During 1942, German U-boats took a heavy toll on merchant marine shipping off the East Coast of the United States. Aircraft scrambled to attack the U-boats, but submarine captains called for crash dives whenever they spotted approaching planes. By the time an aircraft got close enough to fire upon a sub, it had disappeared beneath the surface of the ocean.

Yehudi's inventors needed a way to make the antisubmarine aircraft harder to see, and they realized that camouflage paint wouldn't do the job: Regardless of its color, the airplane would stand out as a black dot against the sky. The only way to make the plane less visible was to light it up like a Christmas tree.

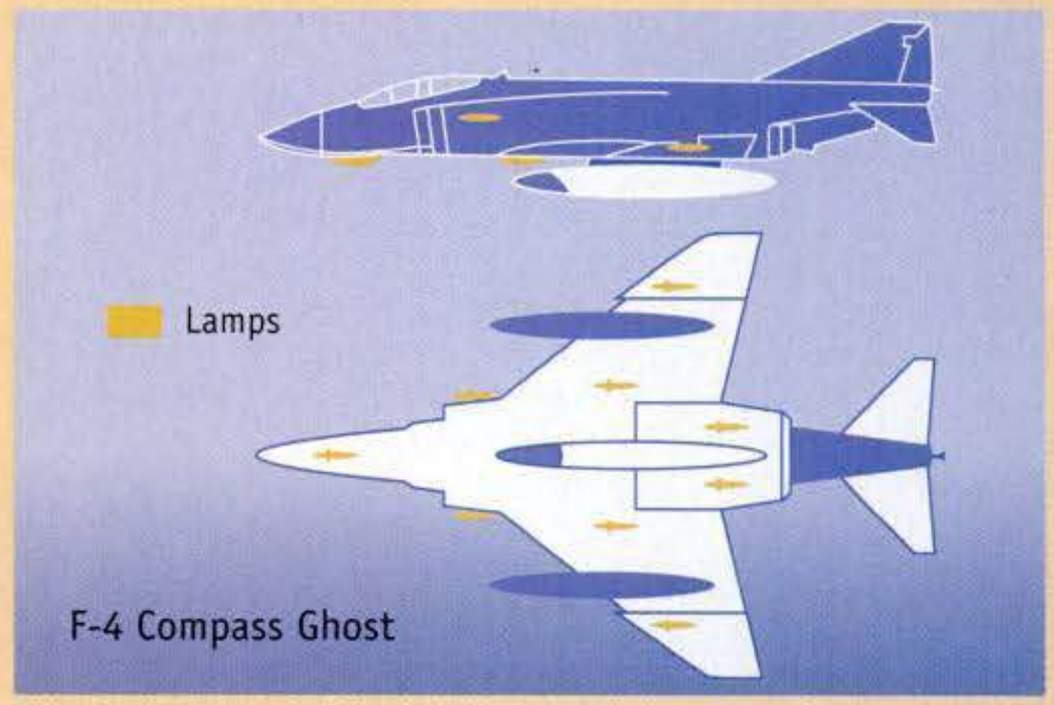
The engineers fitted a portly TBM-3D Avenger torpedo-bomber with 10 sealed-beam lights, installed along the wing's leading edges and the rim of the engine cowling. When the intensity of the lights was adjusted to match the sky, the Avenger blended into the background.

Tests proved that the Yehudi system lowered the visual acquisition range from 12 miles to two miles, allowing the Avenger to get within striking distance of its targets before they submerged. A B-24 Liberator bomber was also modified, with similar results.

Yehudi was not put into production, because better radar had already enabled Navy airplanes to regain the tactical advantage, but the idea was revived after air battles over Vietnam. Concerned that the big F-4 Phantom could be seen at a greater range than its much smaller Russian adversary, the MiG-21, the Pentagon started a program called Compass Ghost. An F-4 was modified with a blue-and-white color scheme and nine high-intensity lamps on the wings and body, reducing the detection range by as much as 30 percent.—*S.D. & B.S.*



Lamps mounted on this bomber made it less visible to enemies.



Lamps and a blue-and-white paint scheme camouflaged the F-4.

ALEX REARDON

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observer, his angle of view, the position of the sun, and the presence of haze or clouds. Altitude is extremely important. A jetliner at its cruising height always appears brightly lit in the sky, because dust and moisture in the air beneath the aircraft scatter light onto its underside. There are relatively few particles of dust and water in the thin air above the airplane. So the higher the plane flies, the more light is scattered onto it, and the darker the sky behind it.

A dark color that absorbs as much light as possible provides the best camouflage for a high-flying airplane. But even the jet-black Blackbird and U-2 spyplanes look brighter than the sky when seen from below as they cruise at 80,000 feet. At lower altitudes, there is less light-scattering atmosphere below the aircraft, so lighter colors provide the least contrast.

For Have Blue, Lockheed devised a scheme of graduated grays, lighter on the bottom and darker on top. The aircraft's designers also planned to test light apertures, which would be installed on the sides and undersurfaces of the airplane, about two feet apart. (Seen from a distance, the individual lights would blur into a single image.) The apertures would be connected to a central light source by fiber-optic lines, and controlled by sensors on the upper side of the aircraft. The sensors would "read" the background light and adjust the skin's luminance to mirror it.

This system never flew on Have Blue, possibly because the first aircraft was lost in an accident. Work on visual stealth continued, however.

In 1980, the Air Force tested a small aircraft, probably unmanned, under a project known as IMCRS (what the acronym stands for is not known). The aircraft's lower wing skins incorporated slit-like Fresnel lenses to beam light ahead of and below the aircraft, in the direction of the most likely threats.

The IMCRS experiment may have been related to a Defense Advanced Research Project Agency program known as Active Camouflage. Under that program, a small, powered drone was fitted with fluorescent lamps and tested at the White Sands Missile Range with so much success that the project has since been reclassified as Top Secret.

Neither of these lighting systems were adopted for stealth aircraft in the 1980s. They were complex to install, and their effects were difficult to predict and test. Carefully designed conventional camouflage worked well enough under most circumstances to ensure that an aircraft would not be visible before a radar could detect it.

So why were the first F-117s painted soot black instead of a toned gray scheme that would provide better camouflage? One Lockheed engineer recalls that the commander of Tactical Air Command "didn't believe that real fighter pilots flew pastel-colored airplanes." An Air Force source close to the program says that some senior officers doubted the F-117 could survive in daylight, and wanted to ensure that nobody would try it.

Color Counts

Light colors would be optimal for the underside of the future Joint Strike Fighter, which will fly relatively low for ground attacks. Some experts say the best color for a fighter is pink, but pilots may object.

JOHN FRASSANITO & ASSOCIATES

ALEX REARDON

The higher an aircraft flies, the darker it should be to hide from enemies. The F-117 was originally painted a dark black, but has recently been seen in gray.

Black is one of the least stealthy colors for daytime flying at medium altitudes. In fact, the British Royal Air Force is painting its trainers black to make them more visible and reduce the risk of collisions. Black isn't much good at night either, because there is nearly always some light from the moon. That's why the latest F-117s have been seen in a more sensible gray color.

The B-2 stealth bomber's underside is a very dark gray. Many people think that it is designed to attack only at night, like the F-117. This is unlikely, because the B-2 was designed to bomb Russia, and the most direct route from the United States lies smack across the Arctic Circle, where the sun shines 24 hours a day for a large part of the year.

The B-2's underside is dark because it cruises at altitudes as high as 50,000 feet, where a dark gray blends

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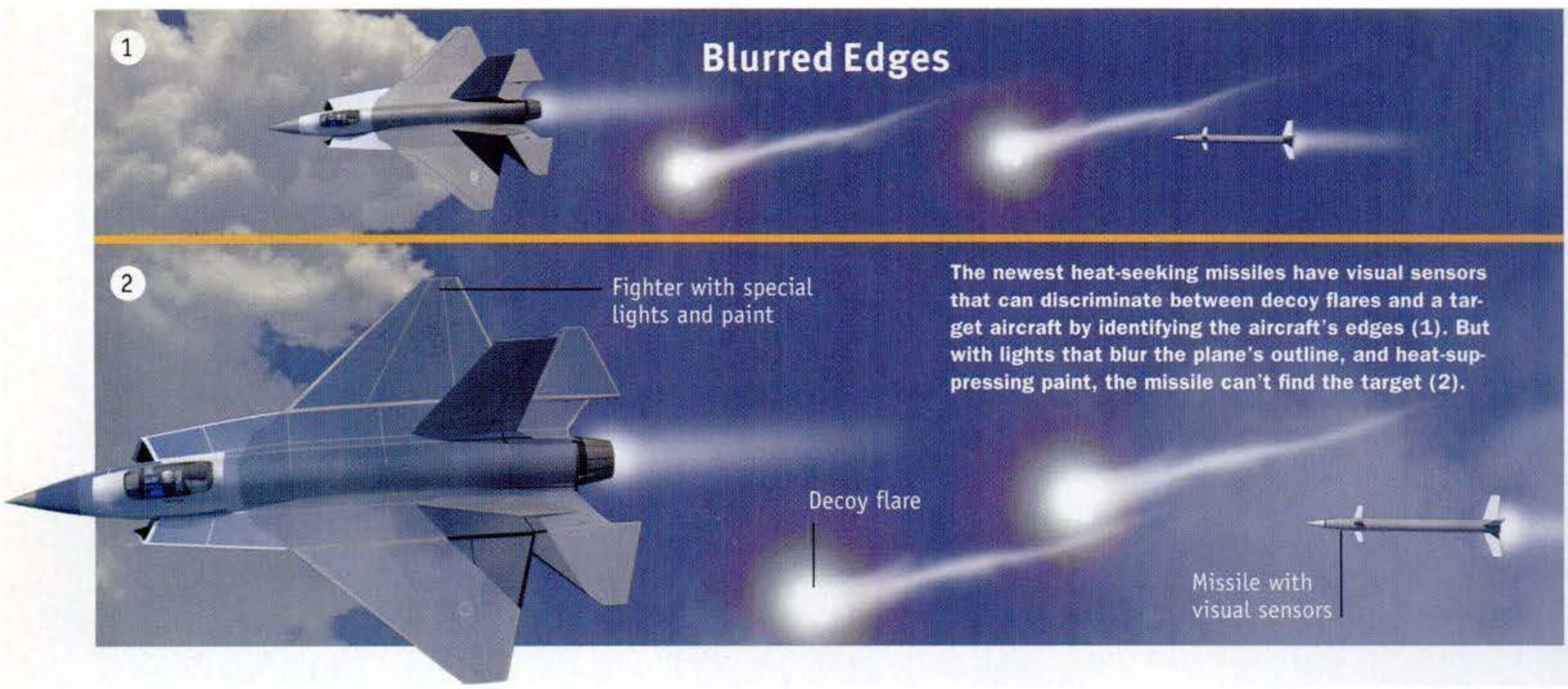
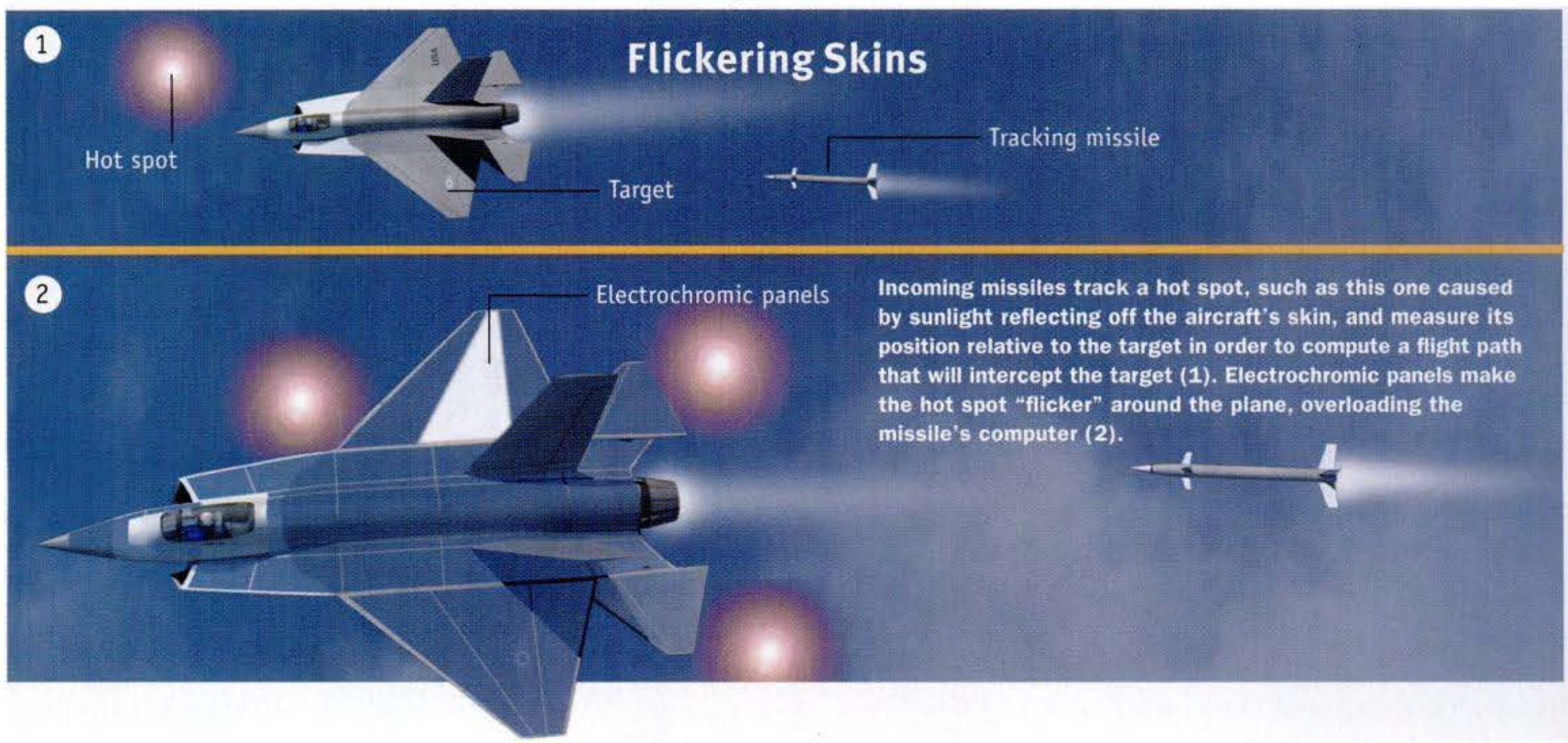


The newest heat-seeking missiles have visual sensors that can discriminate between decoy flares and a target aircraft by identifying the aircraft's edges (1). But with lights that blur the plane's outline, and heat-suppressing paint, the missile can't find the target (2).



Incoming missiles track a hot spot, such as this one caused by sunlight reflecting off the aircraft's skin, and measure its position relative to the target in order to compute a flight path that will intercept the target (1). Electrochromic panels make the hot spot "flicker" around the plane, overloading the missile's computer (2).

JOHN FRASSANITO & ASSOCIATES

into the sky. It does not use an "active camouflage" lighting system, but it may have an upward-facing light sensor that tells the pilot when to increase or reduce altitude to match the changing luminance of the sky.

It appears likely that active camouflage will make a comeback in the 2000s. Improvements in radar stealth have reached a point where visual and infrared signatures are the dominant concerns. One sign of increasing interest in the non-radar aspects of stealth is that the Air Force has commissioned a new flying laboratory called FISTA II (Flying Infrared Signature Technology Aircraft), to replace a vehicle that has been used since the early 1960s to measure the heat signatures of airplanes. A modified tanker aircraft, FISTA II carries not only ultrasensitive infrared imagers, but also a visual imaging system, an indication that the Pentagon is becoming serious about visual stealth.

Modern follow-ons to Yehudi are both more effective and easier to install. Instead of individual lights, the Pentagon has tested thin fluorescent panels of the type already used on military aircraft for nighttime formation flying. A civilian technician working at the isolated Tonopah Test Range airstrip in Nevada says he witnessed a test of an F-15 Eagle with a prototype system. According to the technician, the fighter virtually disappeared as it lifted off the runway.

"We had no problem acquiring the aircraft from about a mile away," the technician recalls, "but at distances over two miles it became harder and harder to spot. Although it was a crude system, it was pretty impressive. Trying to pick out the aircraft against a clear blue sky was next to impossible. The only time we could easily spot the aircraft was when it produced an unexpected contrail." (Contrails form when the water vapor in aircraft exhaust freezes. On the

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B-2 and F-117, anti-contrail systems inject chemicals into the exhaust stream to break water into droplets too small to be seen.)

An even more experimental active-camouflage system uses thin sheets of light-emitting polymer that glow and change color when charged. Different voltages cause the sheets to glow blue, gray, white, or whatever shade is needed to match the sky. As an added advantage, the thin sheets are easy to apply to existing aircraft.

One such "electrochromic" polymer has been developed at the University of Florida, and the Air Force is studying it as a way of applying a variable tint to the cockpit canopy of a fighter aircraft. In theory, such a coating could also be used over a white-painted skin to vary its color.

But what about concealing an aircraft from an enemy flying above it? Defense contractors have told POPULAR SCIENCE that an even more exotic skin is being tested on two stealth aircraft at the high-security Groom Lake air base in Nevada. The skin is derived from an electromagnetically conductive polyaniline-based radar-absorbent composite material. It is optically transparent except when electrically charged, much like the LCDs used in laptop computers.

What makes this new material attractive is that it can change brightness and color instantaneously. Photo-sensitive receptors, mounted on all sides of the plane, read the ambient light and color of the sky and ground. An onboard computer adjusts the brightness, hue, and texture of the skin to match the sky above the plane or the terrain below it.

The system is also claimed to make the aircraft even stealthier. The electrically charged skin dissipates radar waves, reducing the range at which an air defense radar can track the aircraft by as much as 50 percent.

Such systems do not have to be perfect. The goal is not to build an invisible airplane, but to delay the visual detection of an aircraft for as long as possible. In fact, the most effective way of fooling either the eye or a missile may be to present it with an image that is difficult to interpret.

Using fast-changing electrochromic panels, the military is experimenting with "flickering skins" that could prevent missiles from locking onto their targets. In demonstrations at Groom Lake, engineers have turned the entire skin of an aircraft into a missile jammer by applying a special coating that flickers in intensity in both the visible and infrared spectra.

The goal is to delay visual detection.

A flickering skin could help aircraft hide from a new generation of missiles that use visual and infrared sensors to build an image of a target. Older heat-seeking missiles could be lured away from aircraft by decoys—hot flares ejected during flight. But the newer missiles use visual sensors to "see" the edges of an aircraft and distinguish its shape from that of a decoy. A shimmering skin confuses the missile's sensors by displacing or distorting the aircraft's image.

Engineers have also taken steps to reduce the heat signatures of military aircraft. In the 1970s, infrared sensors had a much greater range than visual imaging systems. Infrared accordingly became the stealth designers' second priority, after radar.

Infrared sensors detect hot spots, such as engine exhaust or the wing's leading edges, which are heated by air friction. At closer ranges, sensors detect solar radiation glinting off curved surfaces or scattering from the skin.

Designers countered infrared sensors in several ways. The exhaust nozzles were flattened into slits, because a flat nozzle has a longer perimeter than a round plume, and the exhaust mixes more quickly with the cool air.

Designers also developed paints containing compounds such as zinc sulfide, to suppress reflections from the airplane's skin. Paint cannot eliminate the heat generated by skin friction, but special coatings can change the "emissivity" of the surface—that is, the efficiency with which it transforms heat into infrared radiation. Low-infrared paints and coatings are now widely used on many aircraft.

After years of research focused on the suppression of infrared and radar signatures, aircraft designers now appear to be giving more attention to visual stealth. Some basic physical problems still need to be solved. For example, even a very efficient lighting system requires a lot of energy to match the brightness of the sky, equivalent to several times the power absorbed by the fighter's radar. Experts in the field of electrochromic materials caution that major technical hurdles have not yet been cleared in the unclassified world, and not for lack of interest: The building industry would love to see a practical, large-area electrochromic film, because it could greatly reduce the energy needed to heat and cool buildings.

Electrochromic materials must not only be able to change color, but also to withstand sunlight and extreme weather, and continue operating through many switching cycles. The problems are compounded for a stealth aircraft, because the material must also be compatible with existing radar and infrared technologies. This may well be the reason why, for now, visual stealth measures are confined to a few experimental aircraft—and may stay that way for some time. ◆

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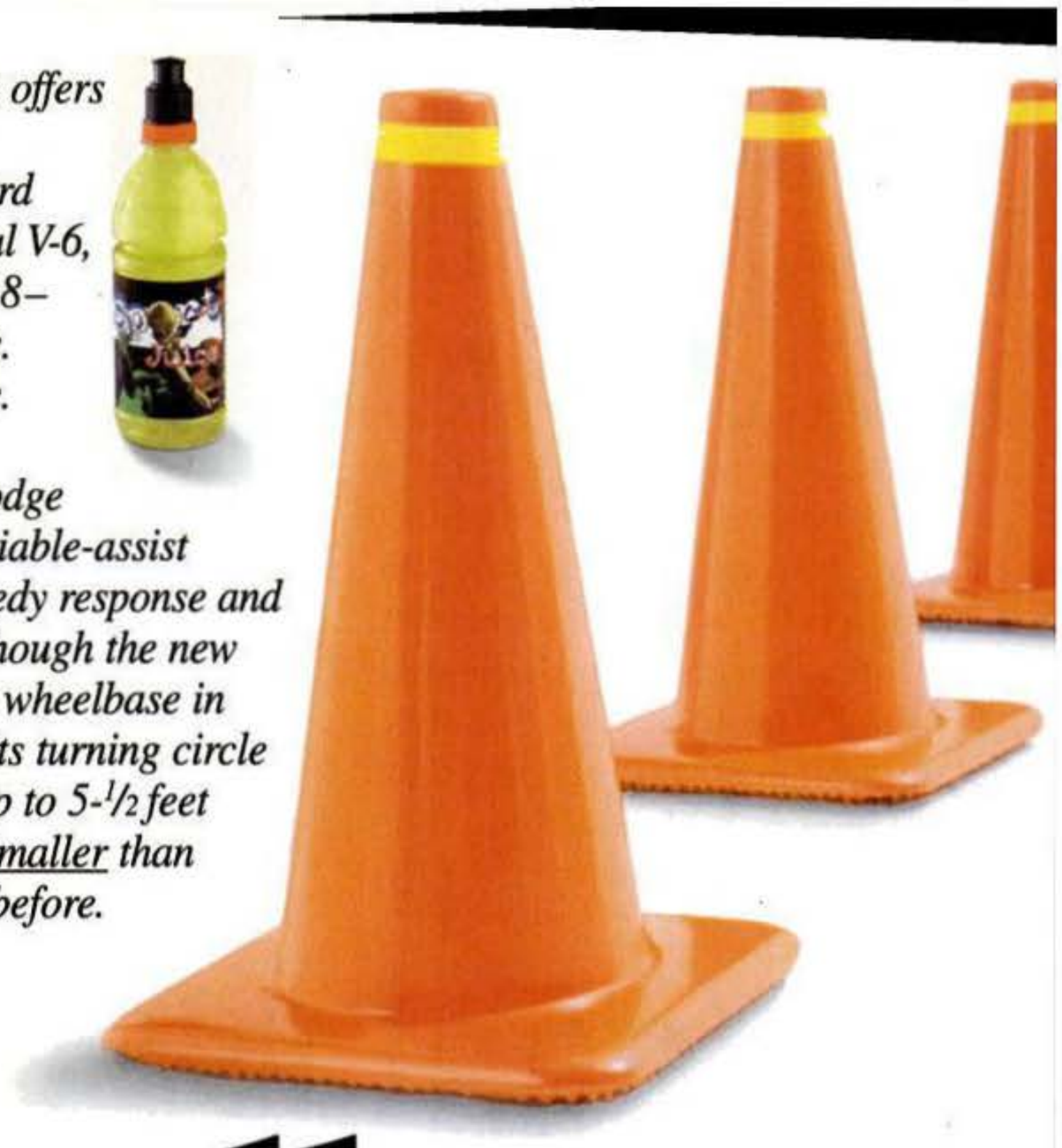
With a wide stance and bigger tires, the all-new Dakota doesn't just grip the road. It puts it in a vise.



Handles pu as well as pile

You get all the capability you've come to expect from a truck that wears the name Dodge. Dakota's maximum available towing and payload capacities, for example, are best-in-class.

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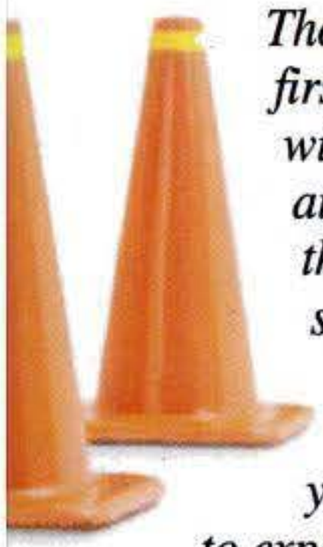
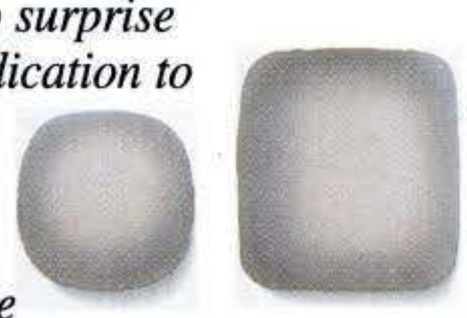


The new Dakota is the first truck in its class with standard dual airbags. No surprise there. A dedication to safety is something you've come to expect from Dodge.*



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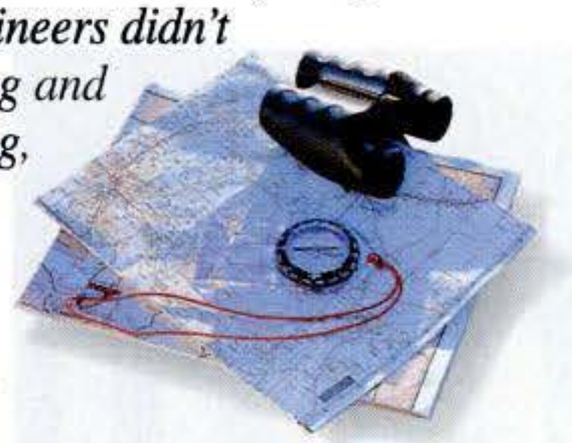

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The New Dodge Dakota
It's full of surprises.

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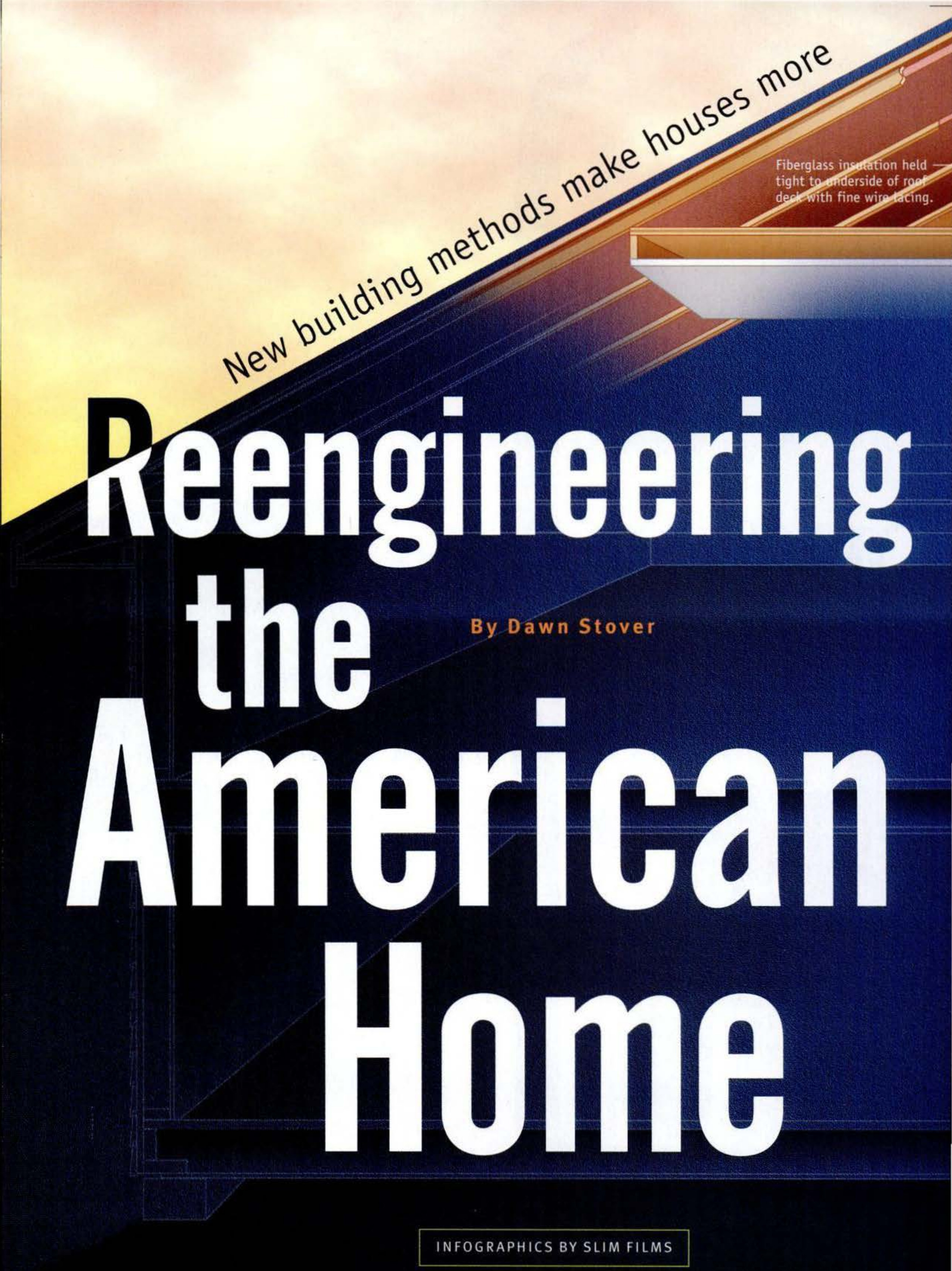
New building methods make houses more



Reengineering the American Home

By Dawn Stover

INFOGRAPHICS BY SLIM FILMS

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energy-efficient—without making them less affordable.

THE 300 HOMES under construction in the Prairie Crossing development northwest of Chicago don't look unusual, inside or out. They're not burrowed into earthen berms, or sparkling with solar panels. Inside the walls are wood studs and fiberglass batt insulation—no straw bales or recycled tires. Yet these homes should use about half as much energy as other nearby houses of the same size. And what's really remarkable is that they cost only about $1,500 more to build.

The houses are part of the Building America program, sponsored by the U.S. Department of Energy. The program's goal is to reduce the energy consumption of new homes by 50 percent without adding *anything* to their purchase prices. To achieve this, the program is

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spending roughly $3 million this year to help teams of home builders develop new building methods.

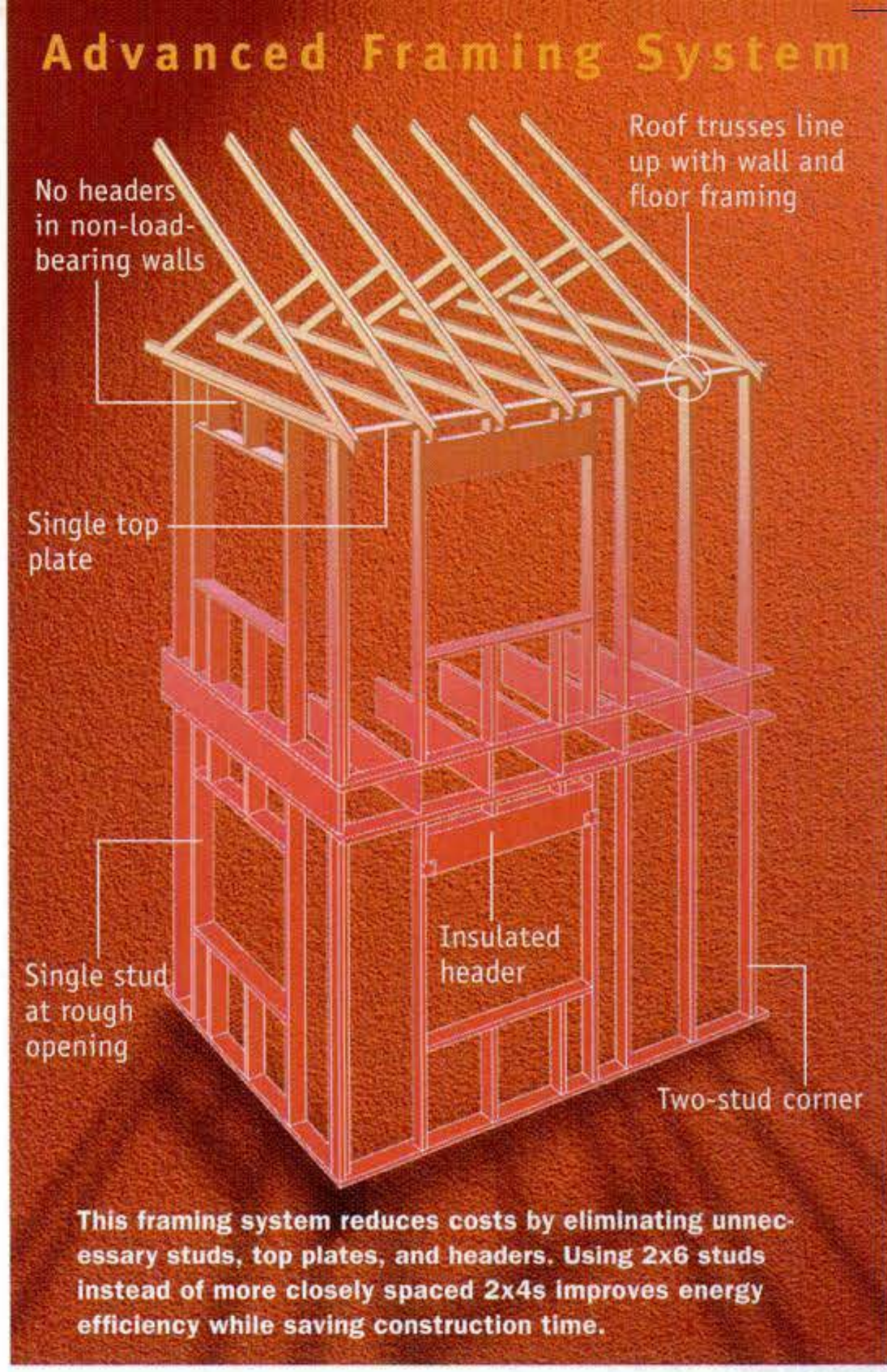
Building America has already awarded contracts to four teams, which have built some three dozen test houses —with hundreds more on the way. Team members come from all segments of the housing industry, such as architects, builders, developers, material suppliers, equipment manufacturers, and financiers. About 70 companies are participating, including Andersen Windows, Carrier, Owens-Corning, Weyerhaeuser, and Whirlpool.

With so many players, the teams can redesign houses from the ground up, so that energy-saving strategies can be incorporated at no extra cost. In the past, cost has prevented many builders, especially those who build tract housing rather than customized homes, from adopting new energy-saving technologies. "One objective is to give participating builders an 'unfair advantage' over competitors," says Sara Farrar, a project engineer at the National Renewable Energy Laboratory, which provides field support for the program. To compete, other home builders will then have to adopt the same energy-saving building methods, or so it is hoped.

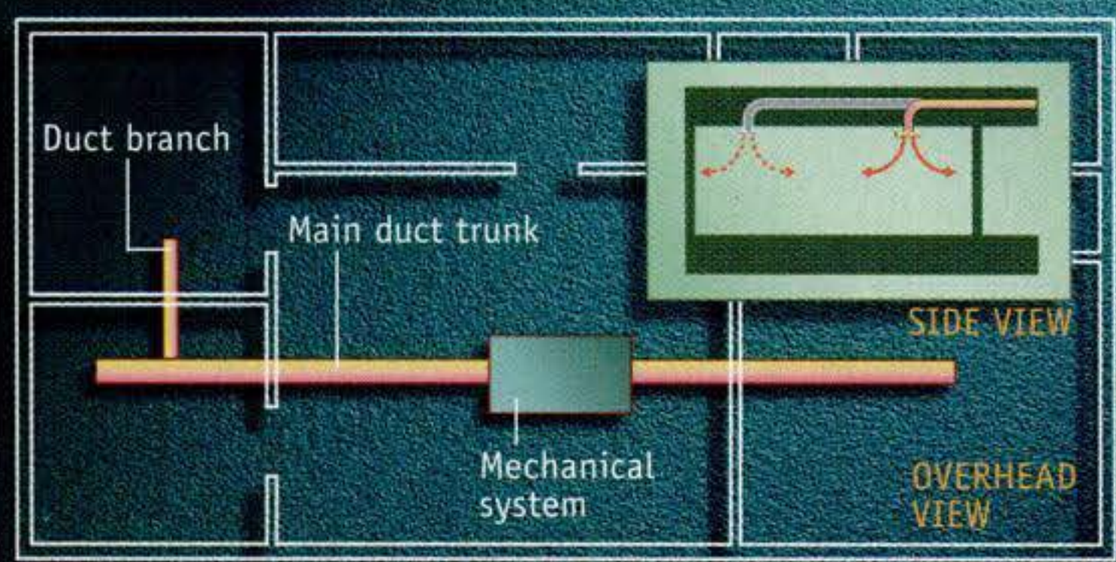
Each team includes at least one production home builder, and just one of these companies may construct more than 5,000 new houses a year. So the program could affect the way large numbers of homes are built.

Two themes have emerged so far. One is that a house should be designed around its mechanical system—the equipment for heating, cooling, and ventilation. The second is that tightening a house's "envelope"—the walls and roof that surround the living space—not only makes a house more comfortable but can dramatically reduce the size and cost of the mechanical system needed.

"Pretend you're Frank Lloyd Wright, and the house revolves around the fireplace," urges architect Betsy Pettit, who heads an industry team called the Building Science Consortium in Westford, Massachusetts. Her team and two others are testing house layouts that place the heating system in a central location. Because the furnace isn't



This framing system reduces costs by eliminating unnecessary studs, top plates, and headers. Using 2x6 studs instead of more closely spaced 2x4s improves energy efficiency while saving construction time.



Placing the heating and cooling system in the center of a tightly sealed house allows builders to use smaller ducts and shorter duct runs to rooms (inset).

far from any of the house's rooms, the builder can use shorter ducts—for fewer energy-wasting leaks. The total duct length required can be cut by more than 50 percent.

The duct shape is different, too: round instead of rectangular. Round ducts are stronger, less susceptible to energy losses from friction, and less expensive. "The only duct cheaper than a round duct is no duct," says Brad Oberg, director of Integrated Building and Construction Solutions (IBACOS), a Pittsburgh-based industry team.

The ducts that IBACOS and the other teams are experimenting with are also smaller than conventional ones. Typically about eight inches in diameter, they fit inside floor trusswork and beneath roof insulation. That means all of the ducts can be kept inside conditioned space, so less energy is lost as air travels through them.

More efficient air delivery means the mechanical system can be smaller, saving money. A standard townhouse built by Ryan Homes, one of the largest U.S. home builders and a member of the Consortium for Advanced Residential Buildings (CARB), has a mechanical system with a capacity of 2.5 refrigeration "tons." But a new test townhouse in Frederick, Maryland, with the same square footage but a redesigned floor plan and ductwork, requires only a 1.5-ton mechanical system.

But the mechanical system can't be downsized unless the building envelope is tightly sealed. So the teams are testing new framing and insulation schemes. One of the most promising of these ideas uses conventional wood studs.

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At Prairie Crossing in Grayslake, Illinois, the framing system places 2x6 studs 24 inches apart, instead of the more traditional configuration of 2x4 studs 16 inches apart. The lumber costs are the same, but the 2x6 system is faster to erect and allows for thicker insulation.

"It's a myth that energy-efficient houses have to cost more."

More savings come from using a single top plate above the walls, rather than the normal double plate. "The roof trusses must line up with the floor joists and wall framing to eliminate the double top plate," Pettit explains. The system also eliminates headers in non-load-bearing walls, and uses only two studs at each corner—instead of three or four.

The Prairie Crossing houses also use a double air-barrier system developed by Pettit and Joseph Lstiburek. One air barrier is created by the interior drywall, which is caulked, glued, or gasketed to the top and bottom plates of the framing. Electrical boxes that penetrate the drywall are sealed with gaskets. Since the drywall is tightly sealed, there's no need for a polyethylene vapor barrier. Rigid foam sheathing glued to the outside of the wall framing creates a second air barrier. The insulated sheathing eliminates the need for bracing or house wrap.

The double air barrier provides insurance against building-crew mistakes: The wall won't leak unless the crew leaves holes in the same section of both barriers. "It's like wearing a belt *and* suspenders," says Pettit.

For hotter climates like Las Vegas, the Building Science Consortium has another unconventional idea for conventional materials. Normally, insulation is placed on the attic floor, and a vent removes hot attic air. But Pettit's team fits fiberglass batts, held in place with wire, between roof trusses. The attic stays cool, and there's no need for an expensive venting system.

Meanwhile, the IBACOS team is studying an idea that not only makes a house's shell tighter, but eases remodeling and repairs. The IBACOS approach, called "disentangling," takes services like plumbing and wiring out of wall voids and places them inside the living space.

Electrical wiring, phone lines, and coaxial cables run inside baseboard raceways. Bathroom pipes are hidden in a three-inch space between the vanity and the wall. The wiring and plumbing don't penetrate exterior walls, so the building shell stays tightly sealed. To rewire the house or repair the plumbing, there's no need to rip a hole in the wall.

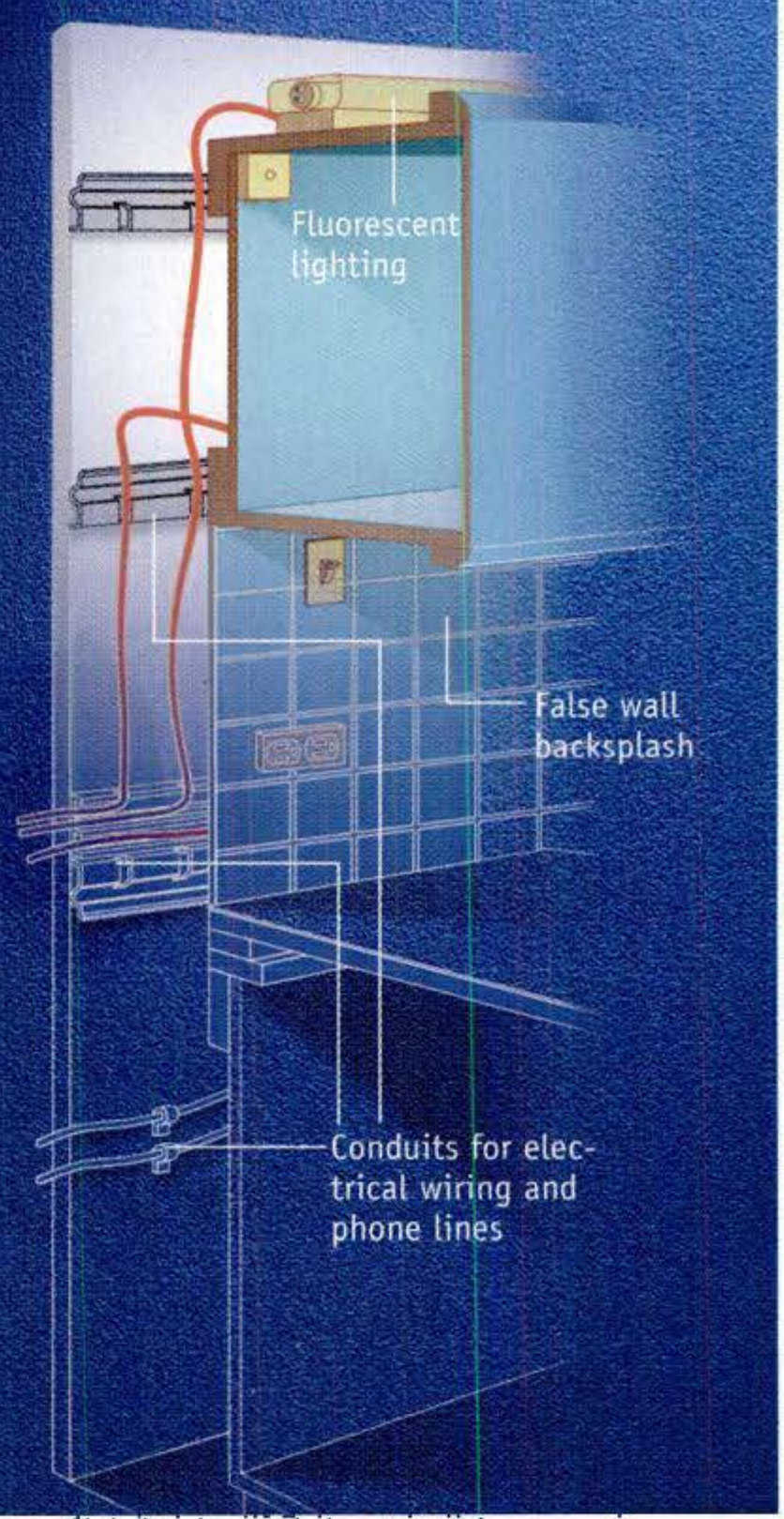
While the others are focusing on site-built houses, a fourth team is working with manufactured housing. For two recently completed townhouses in Cambridge, Massachusetts, the Hickory Consortium of nearby West Wareham used factory-built modules made by Epoch Corp., stacked three high and two deep. Backer rods and cellulose insulation prevent air leakage between modules.

Instead of a simplified duct system, Hickory ductwork divides the house into zones, each with its own thermostat and variable-speed fan. Although this requires complicated electronic controls and duct layouts, it saves energy because you don't have to heat the whole house if you're only using one room. Preliminary tests show the townhouses use 55 percent less energy than required by the state building code, says team leader Mark Kelley.

Home builders are excited about the idea of saving money on both energy and construction. "It's a myth that energy-efficient houses have to cost more," says Building America program manager George James. "By working together using a systems-engineering approach, we can improve quality and performance without increasing cost."

Disentangling

Removing wiring from exterior walls speeds construction and reduces air leaks. In this kitchen concept, raceways for wires make it easy to move appliances or phone jacks to new locations.



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Searching for Water on Jupiter's Moon

New pictures hint at an ocean beneath the frozen crust of Jupiter's moon Europa.

Color Me Icy

False-color views captured by Galileo's multi-spectral camera combine images made with violet, green, and infrared filters to make it easier to distinguish surface features. In this image of Europa's trailing hemisphere (background), the bluish areas represent plains composed of relatively pure ice, while reddish-brown splotches and fractures are likely contaminated by an unidentified rocky material. One of Europa's few large impact craters, measuring 31 miles in diameter, is visible at right, surrounded by a white ejecta blanket of nearly pristine ice. In the more detailed view above, which is roughly 780 miles across, shades of blue and light tan reveal variations in the size of ice grains on Europa's surface.

OUR BLUE PLANET Earth may not be the only object in the solar system with an abundance of liquid water. Recent photographs taken by the Galileo spacecraft are raising scientists' hopes that one of Jupiter's moons may have a life-sustaining ocean hidden beneath its surface.

One of four Jovian satellites that can be spotted from Earth with a good pair of binoculars, the ice-covered moon Europa is slightly smaller than Earth's moon. Europa was first photographed in detail by the twin Voyager flyby probes in 1979.

By Andrew Chaikin

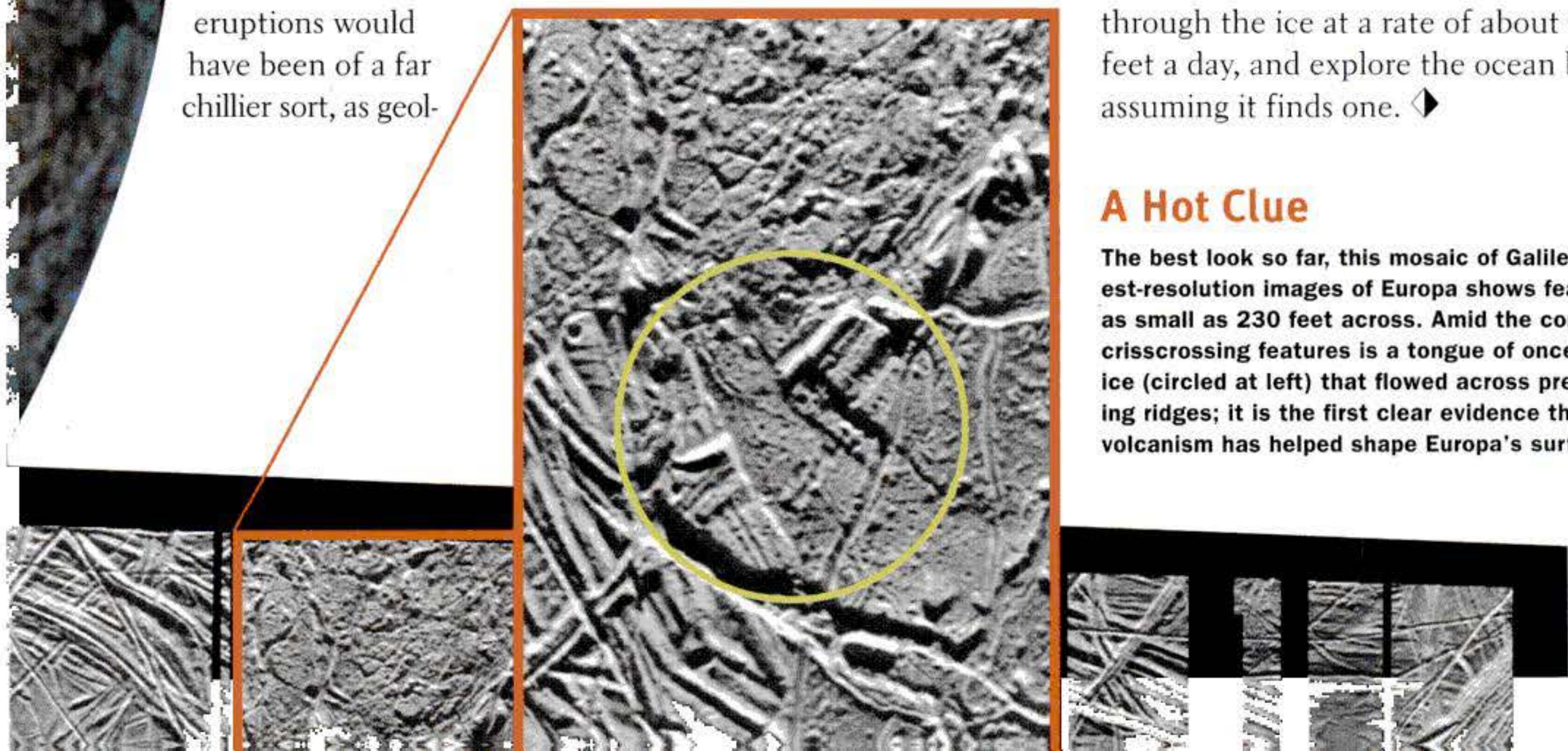
Since Galileo began orbiting Jupiter in 1995, it has sharpened the view, sending back images with up to 200 times more detail than Voyager saw. In addition, Galileo's multi-spectral electronic camera has photographed the moon in a variety of wavelengths, allowing scientists to detect previously unknown variations in Europa's surface characteristics.

The Galileo pictures reveal a complex network of ridges and fractures, some of which resemble features formed by plate tectonics here on Earth. In places, the surface of Europa "looks like a jigsaw puzzle that has been pulled apart," says Torrence Johnson of NASA's Jet Propulsion Laboratory, which manages the Galileo mission. Galileo's closest views appear to confirm the suspicion held since Voyager that Europa has undergone volcanic activity. Unlike terrestrial lava flows, Europa's eruptions would have been of a far chillier sort, as geologist Ron Greeley of Arizona State University explains. "This is clear evidence of cryo-volcanism," Greeley says, describing the flows as "ice or slushy ice." Such outpourings may have buried most of Europa's impact craters. So far, Galileo hasn't shown whether Europa's volcanism is still occurring, but if it is, Greeley says, there is a chance that future images will catch an eruption in progress (as the Voyagers did with pictures of the neighboring moon Io).

What would power these frigid eruptions? Scientists believe Europa's interior is heated by tidal forces generated in an ongoing gravitational tug-of-war among Jupiter and its three closest satellites. With that in mind, some theorists have proposed that Europa's icy crust conceals an ocean of liquid water as much as 200 kilometers deep. That idea in turn has fueled speculation that Europa could be a habitat for living things—perhaps similar to the organisms that flourish in the mineral-laden waters of hot springs on Earth's ocean floors.

But so far, the possibility of life on Europa is nothing more than conjecture. Most scientists agree that the Galileo mission is unlikely even to settle the question of whether Europa has a subsurface ocean. That answer, Greeley says, might come from a future spacecraft equipped with a radar-sounding device to probe beneath the face of the mysterious moon. Called the Europa Ocean Explorer, it could be launched in 2001 or 2002.

Meanwhile two teams have proposed more aggressive missions. The Europa Ice Clipper spacecraft would fire a softball-size copper sphere into the surface, then retrieve ice particles blasted into space by the impact, and bring them to Earth for analysis. A second scheme calls for a probe to land on Europa, melt its way through the ice at a rate of about three feet a day, and explore the ocean below—assuming it finds one. ◆



A Hot Clue

The best look so far, this mosaic of Galileo's highest-resolution images of Europa shows features as small as 230 feet across. Amid the complex, crisscrossing features is a tongue of once-mobile ice (circled at left) that flowed across preexisting ridges; it is the first clear evidence that icy volcanism has helped shape Europa's surface.

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QFTV ➤

SIZE: 42 and 21 inches
PRICE: $25,000 and $10,000
DEPTH: 4 inches
VIEWING ANGLE: 160 degrees
WEIGHT: 65 and 27 pounds
RESOLUTION: 640 by 480 pixels
EXPECTED LIFESPAN: 30,000 hours

◄ PANASONIC

SIZE: 21 inches
PRICE: Not yet announced
DEPTH: 4 inches
VIEWING ANGLE: 160 degrees
WEIGHT: 11 pounds
RESOLUTION: 640 by 480 pixels
EXPECTED LIFESPAN: 30,000 hours

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FLAT TV Arrives

By Dennis Normile

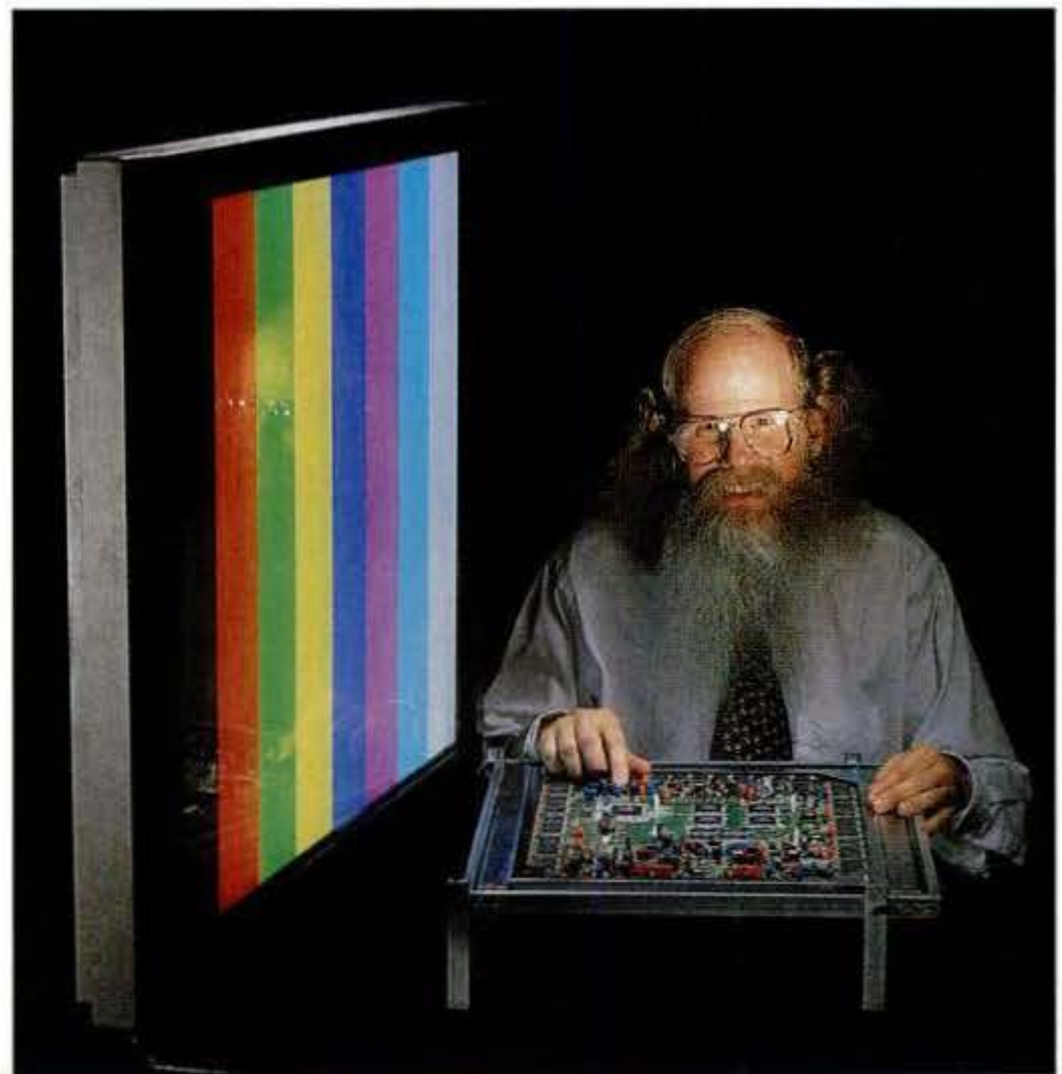
A new technology yields thin TVs light enough to hang on a wall.

FLAT'S WHERE IT'S AT. Take one look at the 42-inch flat-panel television made by QFTV and you know you're looking at the TV of the future. You can hang this set on your wall like a large work of art. The screen size will vary between 21 and 60 inches, yet the depth front-to-back will remain a mere four inches.

QFTV's 42- and 21-inch models are available now at Hammacher Schlemmer stores. The bad news is that the 42-inch model sells for $25,000, while the 21-inch model carries a $10,000 price tag.

The expense is due not so much to the technology but to the cost of manufacturing. Once an efficient mass-production method is developed—companies like Sony and Panasonic are working on the problem right now—you can expect the price to drop dramatically. Within a few years, prices should be comparable to those of projection TVs—roughly in the $2,500 range.

These new TV screens use plasma, or charged gas, to light up the red, green, and blue pixels that constitute an image. The product of decades of research, funded mostly by Japan's leading electronics companies, plasma TVs are suddenly the hottest item in video. Side-by-side compar-



Hang 'Em High TV

Larry F. Weber, president of Plasmaco, heads up the team that developed Panasonic's flat-panel TV. At 11 pounds, it hangs easily on a wall.

PHOTOGRAPHED BY JOHN B. CARNETT

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isons among competing flat-panel TV technologies have not yet been possible. But based on first impressions, the plasma screens, while very exciting, don't yet match the brightness, color saturation, and clarity of conventional cathode-ray tubes. Yet they beat most front- and rear-projection TVs hands down.

Simply put, plasma is the most exciting development in displays since the LCD. And just as the LCD made portable TVs and notebooks possible, plasma displays will lead to a dramatic expansion of how and where we use TVs. Imagine a 42-inch TV hanging on a kitchen wall above the breakfast table. Or how about a 60-inch screen that can be viewed from virtually anywhere in the room at the heart of a home entertainment system.

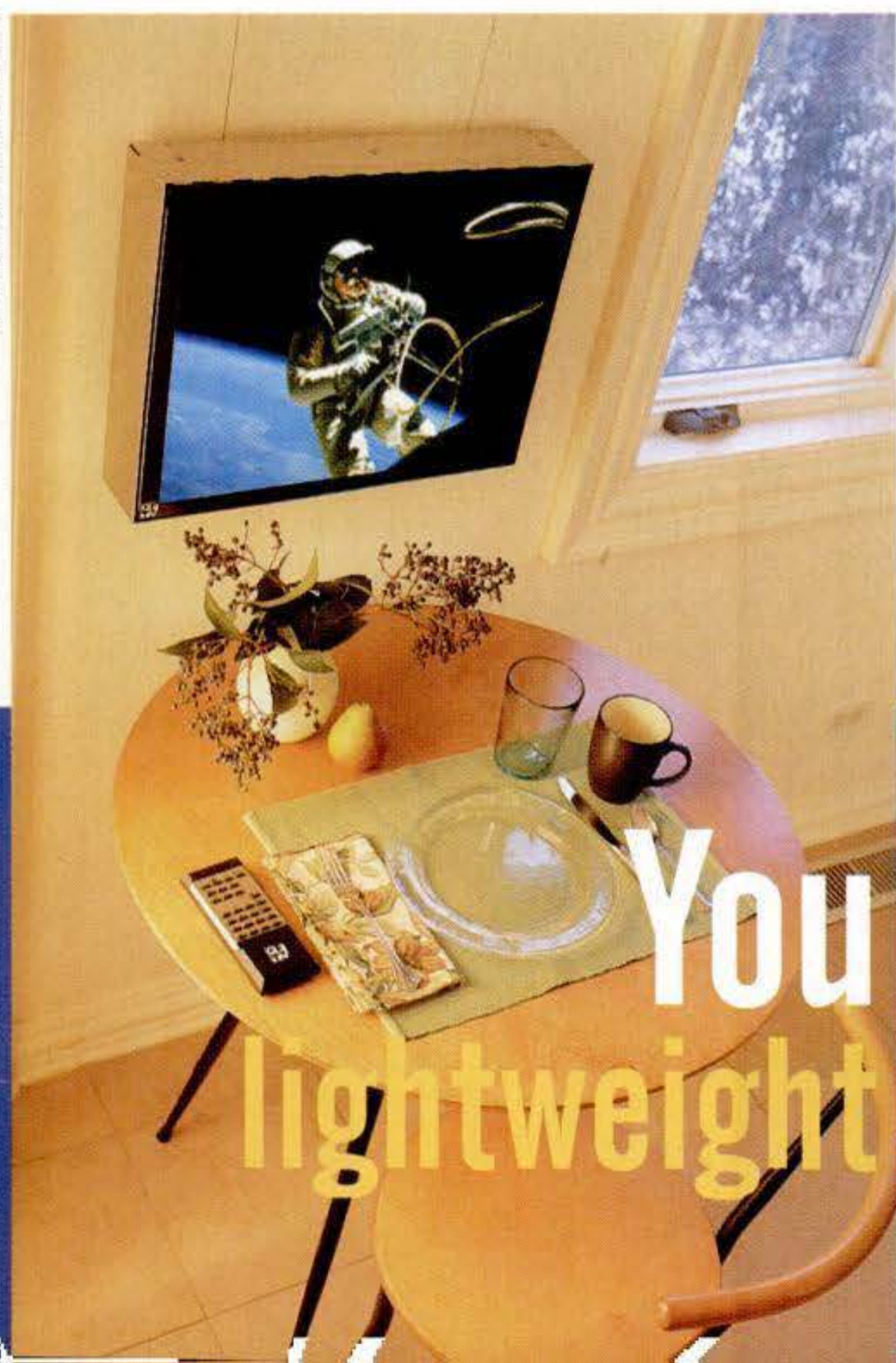
Gas-plasma TV works like a fluorescent light, in that ultraviolet light generated by a gas discharge is turned into visible light by phosphors. In this case, the plasma screens are constructed as a sandwich of glass plates with a gas filling. Applying a voltage causes the gas to emit ultraviolet radiation, which in turn causes red, green, or blue phosphors to glow, emitting the light seen by the viewer. The red, green, and blue phosphors coat U-shaped channels running vertically within the glass plates. Supplying the charge that excites the gas, electrodes crisscross the panel, with horizontal electrodes mounted on the inside of the glass plate closest to the viewer and vertical electrodes behind the gas channels. Pixels are defined by the crossing of the horizontal electrodes and the vertical phosphor-filled channels.

As do the cathode-ray tubes at the heart of most TVs, the new TVs use glowing phosphors to paint television images. In a CRT, however, the phosphors are tiny dots lit up by a stream of electrons fired from a gun at the back of the tube. As a CRT screen gets larger, this electron gun must be pulled farther from the face of the CRT for the electrons to hit the phosphor dots in the corners of the screen properly. And since the CRT is essentially a glass vacuum tube and must withstand pressure from outside, it is difficult to make the screen perfectly flat. The slight curve in the screen inherently produces some picture distortion. Additionally, the bulk and weight of CRTs limits their practical size to about 36 inches. Currently, only Mitisubishi offers a 40-inch CRT television. Plasma TVs, with their sandwich of gas troughs and electrodes, are inherently thin and flat, regardless of their diagonal size.

Of course, liquid-crystal display panels are also thin and perfectly flat. In LCDs, the liquid crystals act as tiny shutters, letting light pass into, or blocking it from, a fluorescent tube at the back of the panel. Color is added by a filter at the front of the panels that has red, green, and blue stripes. The liquid crystals open and close in response to an electric current, which in the most advanced LCDs is switched on and off by a thin-film transistor formed on the rear glass plate.

While the display of choice for portable computers and pocket-sized TVs, the LCD won't become a contender for truly large monitors because the technology is fiendishly difficult to scale up. LCDs are manufactured using semiconductor fabrication techniques, and those processes are primarily aimed at making microscopic devices. Although Sharp, the world's leading manufacturer of LCDs, has developed a prototype 40-inch LCD panel, it required the development of a new technology to seamlessly join together two 29-inch panels. Presently, LCD makers have no plans to mass-produce panels larger than 20 inches in size.

Gas-plasma screens may get smaller if the power efficiency of gas plasma—currently at one lumen per watt—can be improved. "If we can get efficiency up to 5 lumens per watt, then the plasma display will require less power than a backlit LCD," says Larry F. Weber, president of Plasmaco, a flat-panel TV research arm of Matsushita based in Highland, New York. When that requirement is met, building smaller-size gas-plasma displays that would compete directly with LCDs becomes practical.



COURTESY: HAMMACHER SCHLEMMER

You can have a thin, lightweight 21-inch TV hanging above the breakfast table.

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TV's Digital Future

IF FLAT TV is the shape of the future, then the signal of the future is digital. And as with flat TV, the future is closer than you think. The first digital high-definition TV broadcasts are expected late next year, accompanied by large-screen receivers that can display the filmlike programming.

This new era in television won't occur all at once. Digital broadcasts and the equipment to receive them will be phased in gradually. And while broadcasters will be allocated new digital television (DTV) channels, the sky won't go dark anytime soon for today's conventional analog TVs.

DTV, sometimes called high-definition TV (HDTV) or advanced TV (ATV), relies on MPEG-2 compression algorithms to fit all the extra visual information required for the more detailed resolution into the channel used to transmit a single analog program today. Alternatively, MPEG-2 could be used by a broadcaster to transmit at least four programs with today's analog resolution in the single channel. Most will try to make a big impression with high-resolution DTV, but you can expect different approaches during the transition period.

The go-ahead for DTV came last December, when the Federal Communications Commission approved the use of 18 video formats of various resolutions, along with the Dolby Digital six-channel surround-sound system. Experimental DTV stations already are up and running. At next January's Consumer Electronics Show, manufacturers will preview the first DTVs, in anticipation of broadcasts commencing that fall.

When DTVs hit retail shelves, they will most likely be large-screen front- and rear-projection models. Manufacturers say that prices will run $1,000 to $1,500 more than TVs of comparable size and features.

If you're thinking of buying an analog TV today, go right ahead. There won't be a lot of DTV broadcasting for a while, and DTV prices will fall over time. Thomson Consumer Electronics, whose RCA brand will be among the first in DTV along with Philips, Sony, and Zenith, speculates that DTV will command only a $500 to $700 premium within five years, and cost just $200 or $300 more than conventional TVs after 10 years of DTV broadcasting.

Meanwhile, sometime in 1999, you'll be able to buy a converter that will enable your current TV to receive DTV programs. These converters might cost about $1,000 at the start. They won't, however, give you full DTV. Neither will some new TVs marketed as DTV. Here's why.

With the converters, you'll be receiving the DTV signal and its programming, but your TV display will be limited to its current resolution. Increasingly, high-end projection TVs available now can display a very good picture—equivalent to SVGA-level computer images. But no TVs currently available—including the new flat, plasma displays—can handle the highest DTV video format, whose resolution is 1,920 by 1,080 pixels.

TV manufacturers are confident they'll be able to build front- and rear-projection models that achieve DTV's highest resolution. They say it's a matter of developing projection CRTs (cathode-ray tubes) capable of beaming a finer spot than do the tubes being used today. But direct-view DTV might be longer in coming.

This is because tube TVs need a shadow mask (or aperture grille) to direct electron beams to the correct phosphor and create a pixel. Fabricating metal masks with the necessarily finer apertures is a challenge. Even if it's accomplished, the TV picture might not have brightness comparable to today's TVs—the smaller the aperture, the less light is emitted. This won't be an issue with DTV-capable PC monitors, which are viewed from a distance of about two feet, and don't have to compete with ambient light across the length of a room.

In the short term, DTV will come in two flavors, according to Glenn Reitmeier, senior director for high-definition imaging at the David Sarnoff Research Center, a TV lab. Projection DTVs that measure at least 60 inches diagonally and that are viewed from beyond eight feet will feature 1,920 by 1,080 resolution, while the largest direct-view tube sets (perhaps 38 inches diagonally in the wide-screen 16:9 aspect ratio) will max out at 1,280 by 720 pixels.

How long today's analog signals will remain available is not yet clear. It will probably be determined by household penetration of DTV over time. RCA speculates that DTV sales will reach 1 million annually in 2002—still a far cry from the 25 million conventional TVs sold this year. This much is clear: Those telecasters who convert to DTV must begin returning their analog channels to the FCC in 2006. By that time, TV makers expect to offer inexpensive converters for older sets.—*Stephen A. Booth*

Digital Timeline

A new era in television is expected to begin next year with the introduction of digital TV. Here's the plan for the rollout.

SPRING 1997 — Empire State Building in New York begins experimental broadcasts from WCBS-HD.

WINTER 1998 — First digital TVs preview, mostly front- and rear-projection models.

FALL 1998 — Commercial broadcasts begin; digital TVs go on sale at prices $1,000 to $1,500 more than analog TVs.

SPRING 1999 — Adapters for conventional TVs introduced.

WINTER 2002 — Digital TV sales reach 1 million annually; prices come down.

CIRCA 2006 — Broadcasters begin returning analog spectrum, signaling phaseout of today's NTSC TV channels.

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While plasma TVs have only begun to hit the market, the technology is actually very mature. Gas-plasma displays were developed in 1964 by Donald. L. Bitzer and Gene Slottow, two professors at the University of Illinois. Over the years, incremental improvements have occurred—color panels were developed in 1975 and the current structure of the panels was devised in 1986—until a critical mass was reached. Suddenly, large-scale production of flat-panel TVs seemed possible.

Last fall's Japan Electronics Show was something of a coming-out party for plasma TVs. Sony, Fujitsu, NEC, and Matsushita, maker of the Panasonic and National brands, all showed off the prototype products that are now reaching the stores. Other companies also working on flat-panel TVs include Mitsubishi, Pioneer, Thomson (RCA), and Hitachi. **All of these companies are planning to sell plasma TVs under their own brand names and to supply the plasma panels to other manufacturers for use in their brands.** The first of these was put on the North American market by QFTV, the specialty reseller of TVs and monitors, and sold through the Hammacher Schlemmer catalog. QFTV uses flat-panel TV technology developed by Fujitsu. But other electronics manufacturers will soon be following suit. Fujitsu plans to sell a 42-inch model under its own brand name for roughly $13,000. By the end of this year, a selection of plasma TVs from a range of manufacturers is likely to be in electronics showrooms across the country.

While all these companies are using the same basic technology, there are subtle differences in approach. Both Fujitsu and NEC are using what's called AC surface-discharge technology. In this technique, alternating current charges the gas. The plasma cell is first charged by passing a voltage between a horizontal scanning electrode in front of the plasma channel and a vertical data electrode behind it. That initial charge is then held by passing a voltage high enough to sustain but not initiate plasma discharge between the scanning electrode and a third electrode running parallel to it. This creates a bubble of charged plasma that is confined to the area between the two horizontal electrodes. This approach to minimizing crosstalk, or the smearing of the signal to adjacent pixels, allows the use of channels without any barrier separating horizontal rows of pixels.

Engineers at Matsushita, however, think the AC surface-discharge technique will prove difficult to apply to the greater number of pixels needed for high-definition television displays. While Matsushita also intends to manufacture and sell plasma TVs based on this AC surface-discharge approach, it is also continuing to work on a competing DC pulse memory technology originally pioneered by NHK, Japan's public broadcast network. In this approach, instead of only vertical ribs, there are ribs running both vertically and horizontally, creating an egg-crate structure. Each of these little lidless boxes is coated with phosphor and defines one pixel. Using direct current, a voltage is applied between a clear cathode in front of the grid of boxes and an anode behind it. Matsushita engineers believe this technology results in higher contrast and faster response.

But the additional ribs make manufacturing the panels more difficult, and the direct-current approach generates more heat than the alternating-current scheme.

A Low-Cost Alternative

A NOVEL DISPLAY TECHNOLOGY recently developed in the United States promises flat, large-screen monitors and TVs at a fraction of the cost of liquid-crystal displays or gas-plasma screens.

The technology, called High-Gain Emissive Display (HGED), can produce flat panels measuring 5 to 40 inches diagonally, according to Telegen Corp., the developer. The Redwood, California-based company claims several patents for the process, some still pending.

Jessica Stevens, Telegen president and chief executive officer, says HGED screens can be made more cheaply than either LCD or plasma displays—at about $1.30 per square inch, compared to $16 for LCD or plasma. And whereas newly-available 42-inch plasma displays cost $10,000 or more, a 40-inch HGED screen could sell for about $2,000 and would weigh less—about 15 pounds versus 40.

Stevens explains that HGED is less expensive to produce because clean room conditions and micron tolerances aren't necessary. Consequently, building a factory costs $50 million, compared to nearly $1 billion for other methods.

HGED panels contain color phosphors similar to those used for cathode-ray tubes, but modified to operate at extremely low voltage (under 100 volts). They are activated by a matrix grid instead of the beam-steered, high-voltage electron gun used in CRTs. Unlike LCDs, the matrix needs no transistors to address the pixels. Rather, the phosphors are excited by electrons guided to the grid through a method Telegen is patenting.

Although HGED technology has been in gestation since the early 1980s, Telegen says it only recently became feasible with the advent of inexpensive microprocessors. The company notes that the displays can deliver the brightness and color palette required for TV, as well as the resolution and refresh rates needed for computer- and high-definition video applications. Compared to LCD, the viewing angle is not restricted. Meanwhile, the use of extreme low-voltage phosphors eliminates concern over X-ray emissions in near-field viewing situations.

Telegen says the first HGED product will be a 20-inch desktop PC monitor, to be manufactured under license by Singapore-based IPC-Transtech.—*S.A.B.*

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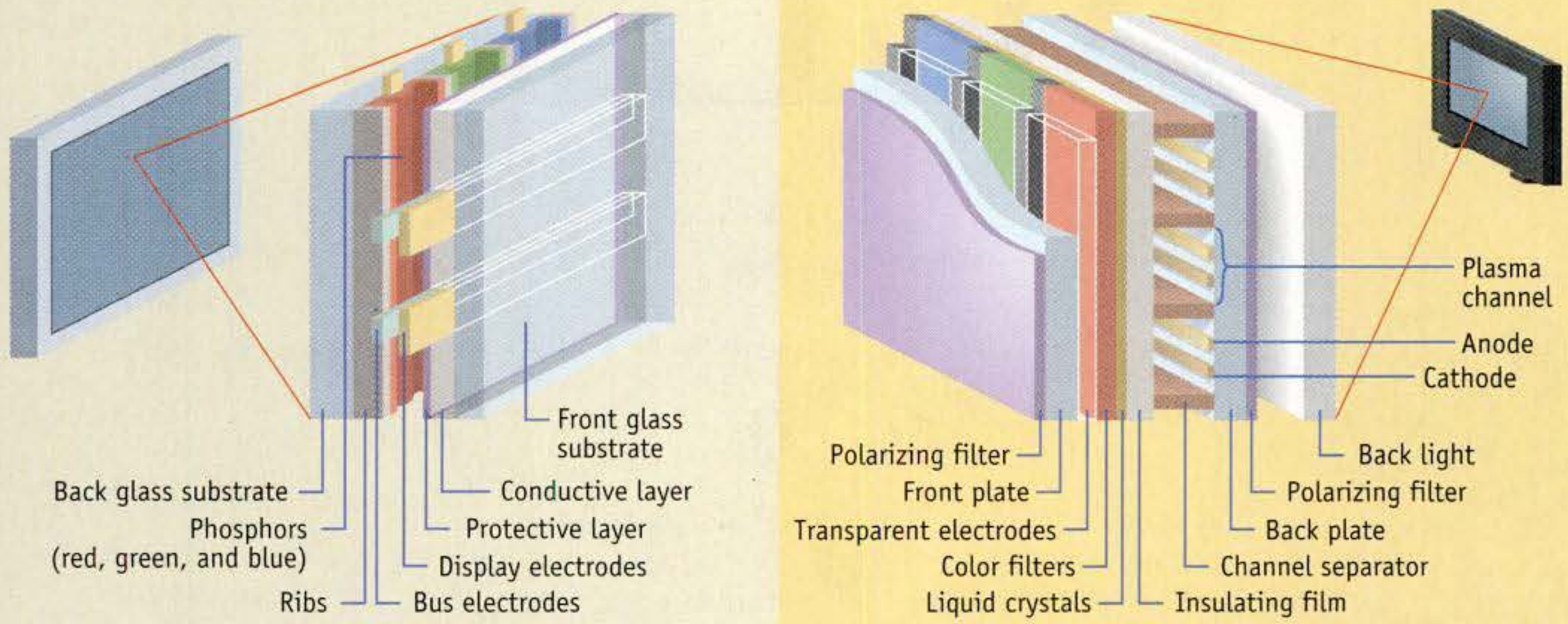
Gas-Plasma Displays vs. Plasma-Addressed LCD Screens

GAS PLASMA sandwiched between two glass panels is electrically charged to produce ultraviolet light, which is then turned into visible light by red, green, and blue phosphors. This technique works well for large screens.

SONY'S PLASMATRON marries gas plasma and liquid crystals. The gas plasma acts as an electronic on/off switch that opens and closes the liquid crystals, allowing light from the rear to pass through as needed.



K. DANIEL CLARK

Matsushita currently sells a 26-inch DC model for commercial use in Japan.

Meanwhile, Matsushita's AC surface-discharge approach is actually spearheaded by Plasmaco, its U.S. subsidiary. Plasmaco has already built a 21-inch prototype with a 640- by 480-pixel resolution. Like other gas-plasma TVs, the Plasmaco unit features a wide, 160-degree viewing angle that supersedes the capabilities of LCD screens. The 11-pound screen can also be used as a computer monitor, which may make this technology well-suited for use in hybrid PC/TV applications. Switching between the PC and TV may be a simple as flipping a switch.

Ever the independent, Sony has yet another completely different approach, which blends liquid-crystal and plasma technology. This plasma-addressed liquid-crystal technology was originally developed by Tektronix of Beaverton, Oregon. Just as in typical LCDs, the liquid crystals act as shutters, letting light pass to, or blocking it from, a back light. Instead of being controlled by thin-film transistors, however, the current through the liquid crystals is turned on and off by using the charged plasma, which conducts electricity, as the switch.

The plasma is in channels running horizontally across the screen behind the layer of liquid crystals. Each plasma channel corresponds to a television scanning line. One by one, from top to bottom, the channels are charged by passing a voltage across electrodes at the back plate of the panel. Once the channels are charged, the plasma can conduct electricity, with the circuit through the liquid crystals completed by transparent electrodes mounted in front of the liquid-crystal layer.

The reason the plasma approach works when thin-film transistors don't is because of the difficulty of scaling up the thin-film-transistor manufacturing process to the panel sizes needed for larger displays. Sony claims its Plasmatron will be easier to manufacture and have higher picture quality than the competing plasma schemes. The drawback: This approach doesn't offer as wide a viewing angle as gas-plasma screens, since the screen is still essentially an LCD. The Plasmatron also requires more power, since the backlight must be constantly on.

These different approaches produce pictures of varying quality. But even within a single approach, the results from one brand to another may differ. For instance, Plasmaco uses a contrast ratio specification of 200:1 while QFTV's is 60:1, a difference that may account for the washed-out look of the latter screen. But with a variety of flat-panel technologies now available, the biggest challenge today is cutting manufacturing costs, though this is a chicken-and-egg situation. Efficiencies of scale will mean lower costs, but to generate sales volume, the price of the panels will have to come down. An industry goal is to cut the price to roughly $100 per inch of screen size by 2000.

Even at such prices, electronics firms are confident plasma screens will be in demand. Fujitsu recently refurbished an existing semiconductor factory, completely devoting it to producing 10,000 42-inch plasma screens per month. Within two years, the company plans an expansion that will allow it to manufacture large screens at a rate of as many as 100,000 panels per month. Other manufacturers are making similar investments. To soak up all that capacity, plasma TVs will have to start appearing on more living room walls. Which means they will have to be affordable. ◆

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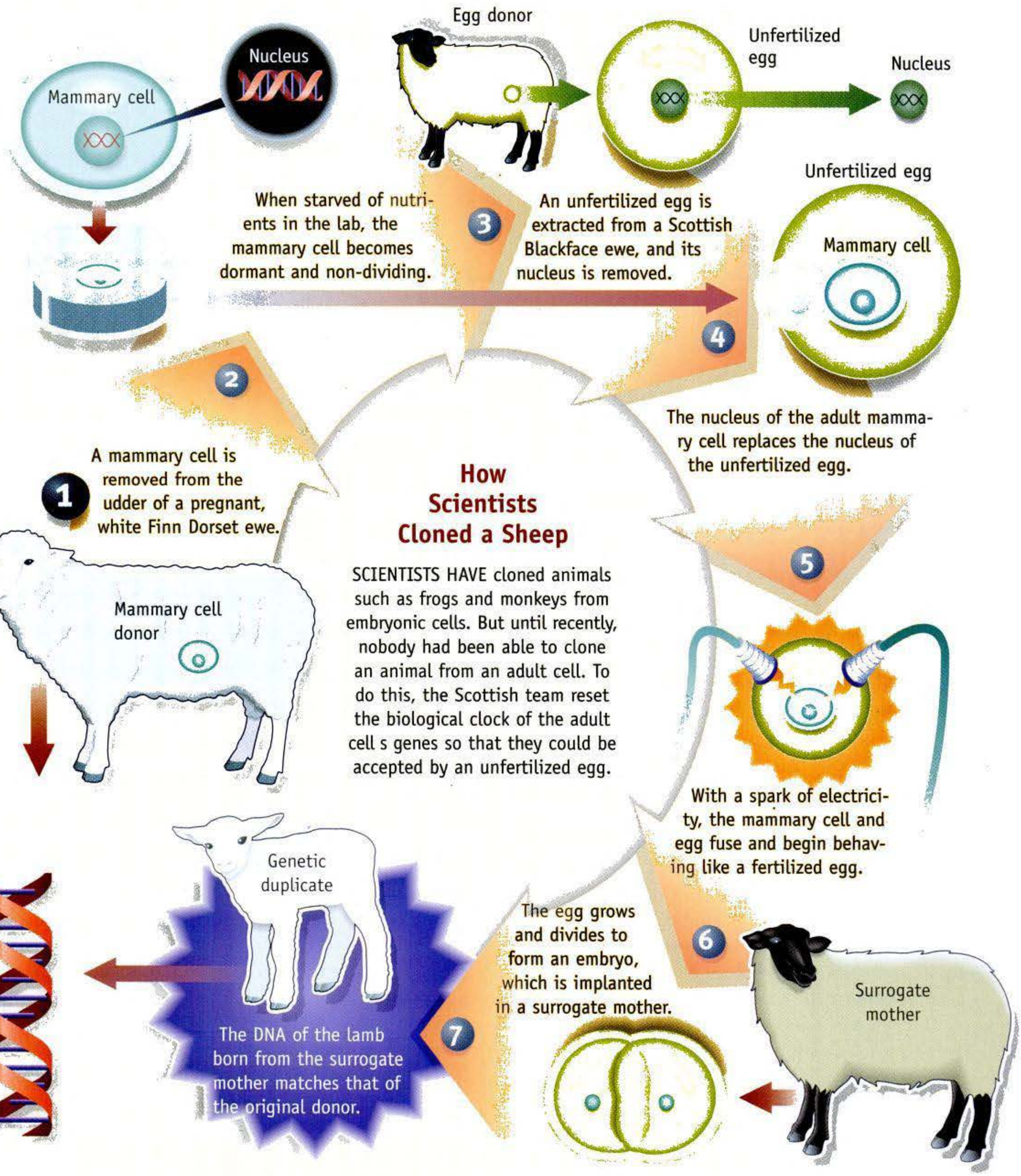
Counting 6LL3



How Scientists Cloned a Sheep

SCIENTISTS HAVE cloned animals such as frogs and monkeys from embryonic cells. But until recently, nobody had been able to clone an animal from an adult cell. To do this, the Scottish team reset the biological clock of the adult cell s genes so that they could be accepted by an unfertilized egg.

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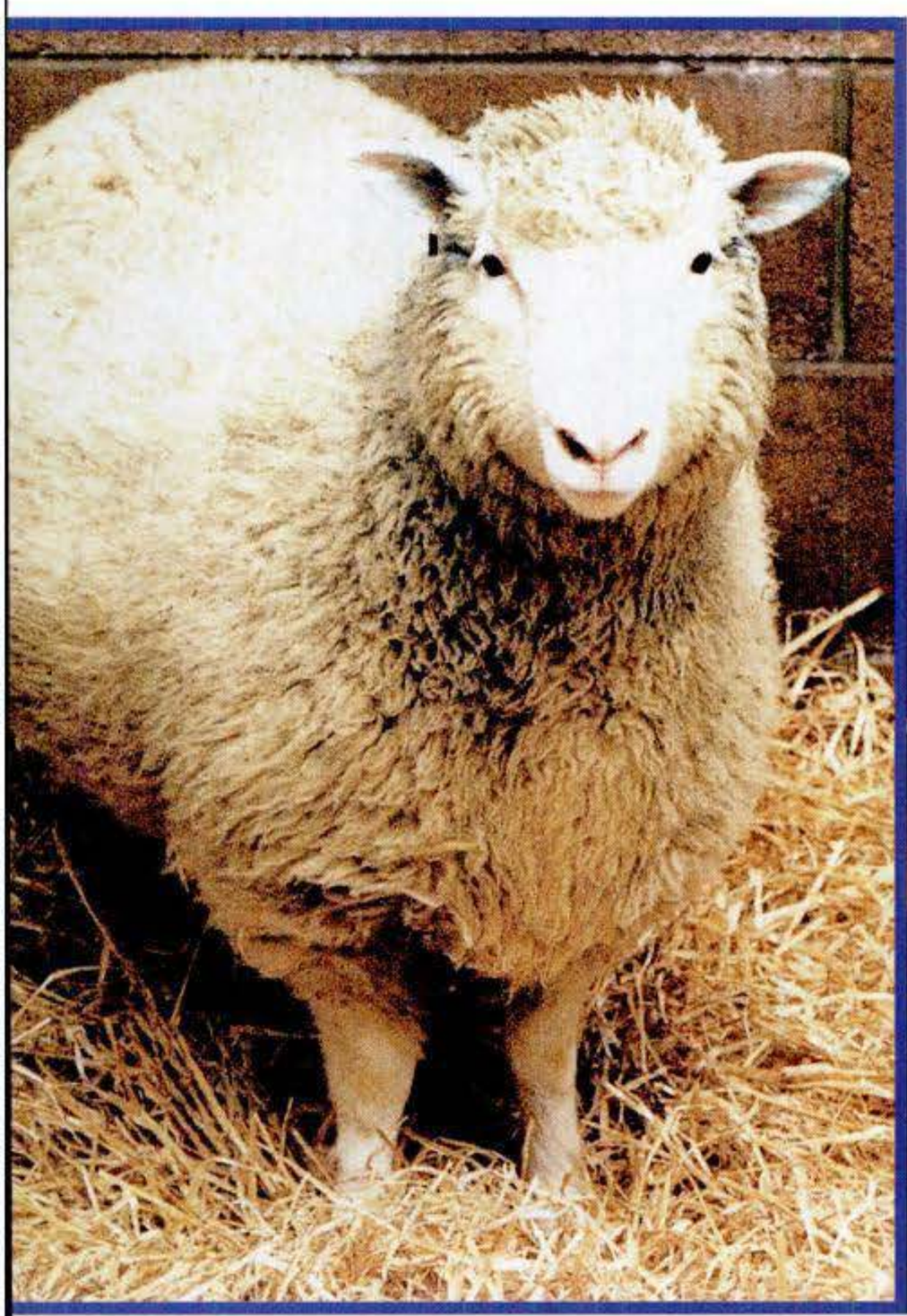
Ian Wilmut clones a sheep, but he isn't losing any sleep.

By Mark D. Uehling



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ARCHIVE PHOTOS/REUTERS/IAN WALDIE

Ian Wilmut led the team that cloned Dolly the wonder lamb from the cells of an adult sheep.

THE BAAA HEARD 'round the world came from a lamb named Dolly, and it called into question the very idea of identity. Dolly's anonymous mother, as the world now knows, was the first adult mammal ever cloned. The scientist responsible is Ian Wilmut, an embryologist at Edinburgh's Roslin Institute who has spent two decades studying eggs and sperm and how they develop.

First, Wilmut and his colleagues scraped the udders of an anonymous, pregnant, white Finn Dorset sheep for membrane cells. Such cells are usually kept alive in a liquid of 10 percent fetal calf serum, the fluid component of blood, which is rich in foodlike cellular nutrients. But Wilmut realized that a standard technique to put cells to sleep—reducing the level of serum to 0.5 percent—could make the cell "forget" that it was a mammary cell and enable it to "remember" the genetic instructions for making an entire sheep.

That was a philosophical breakthrough: Other scientists had not understood the importance of synchronizing the development of a cell's genetic material with that of the egg that would receive it. In the past, at other labs, the genes had raced too far ahead in development to be activated by eggs. Wilmut's cells, however, had not begun to divide and translate their DNA into the stuff of sheep.

In their quiescent state, the mammary cell's genes were ready to be combined with an egg. The scientists harvested eggs from smaller Scottish Blackface sheep, and surgically removed the cells' nuclei (where the DNA resides). Wilmut and his team then placed the white-sheep udder cell and the nucleus-free, black-sheep egg next to each other. In a Frankensteinian trick, electricity was applied. The membranes of the cells fused and—presto—two cells were one. The fused egg was implanted in a blackface ewe using standard artificial fertilization techniques.

When a veterinarian finally delivered the wonder lamb four months later, its color—white—was a hint that it was not the same breed as the ewe from which it had emerged. DNA tests took months but finally confirmed that Dolly, or 6LL3 as she was known in the lab, is indeed a biological copy.

Wilmut's achievement is so impressive that even the Vatican and President Clinton have commented on it. The only good news for people frightened about another Hitler is that it will not be repeated by a crazy scientist working alone. Why? Too many diverse areas of expertise are required. But in principle there is nothing to prevent a wealthy person from cloning himself, cloning a California condor, cloning 500 Marilyn Monroes—or, to be precise, 500 Monroe bodies without Marilyn's formative experiences.

Wilmut himself seems miffed that anyone would want to clone something more controversial than, say, a sheep genetically engineered to produce drugs in its milk, or a pig with organs that could be transplanted into humans. "There is no reason in principle why you couldn't do it," he says of cloning a two-legged Dolly. But, he adds, "All of us would find that offensive. I don't have sleepless nights." ◆

INFOGRAPHIC BY JUAN VELASCO

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Lethal

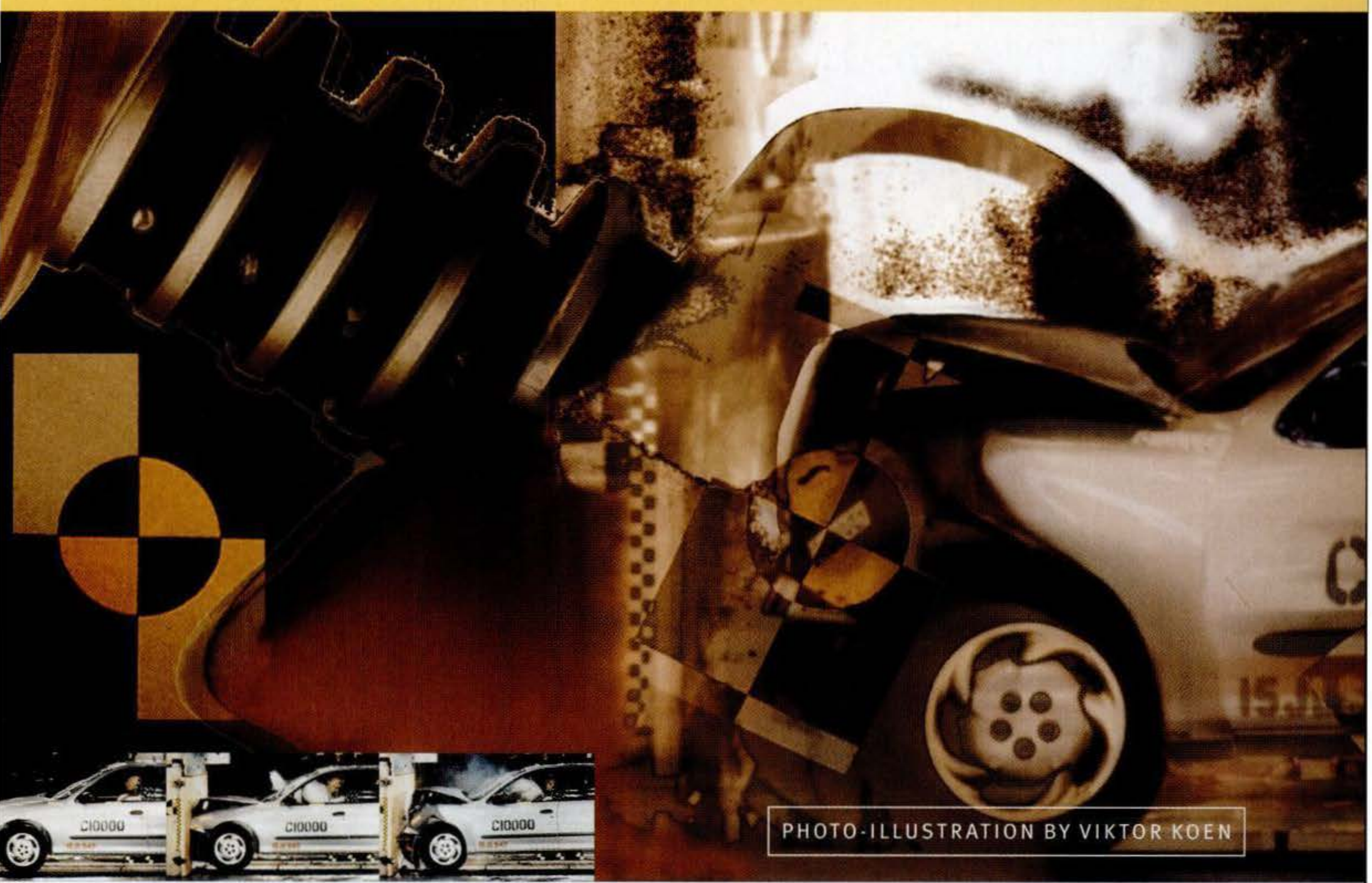


PHOTO-ILLUSTRATION BY VIKTOR KOEN

Airbags aren't the final solution to keeping you alive in a crash.

By Daniel McCosh

IF YOU'RE WORRIED about the power of your car's airbag in a car crash, consider the exploits of Col. John Stapp.

It's the summer of 1954, and in the hot desert of New Mexico, Stapp, strapped into the seat of a rocket sled called the Sonic I, is hurtling at 632 mph toward a land speed record. He also is about to run into a wall, which makes the speed record somewhat incidental. In the next few seconds, a steel lip hanging below the sled will hit a trough of water between two steel rails, and the impact with the incompressible water will bring Stapp and the Sonic 1—in a mere 1.4 seconds—from a

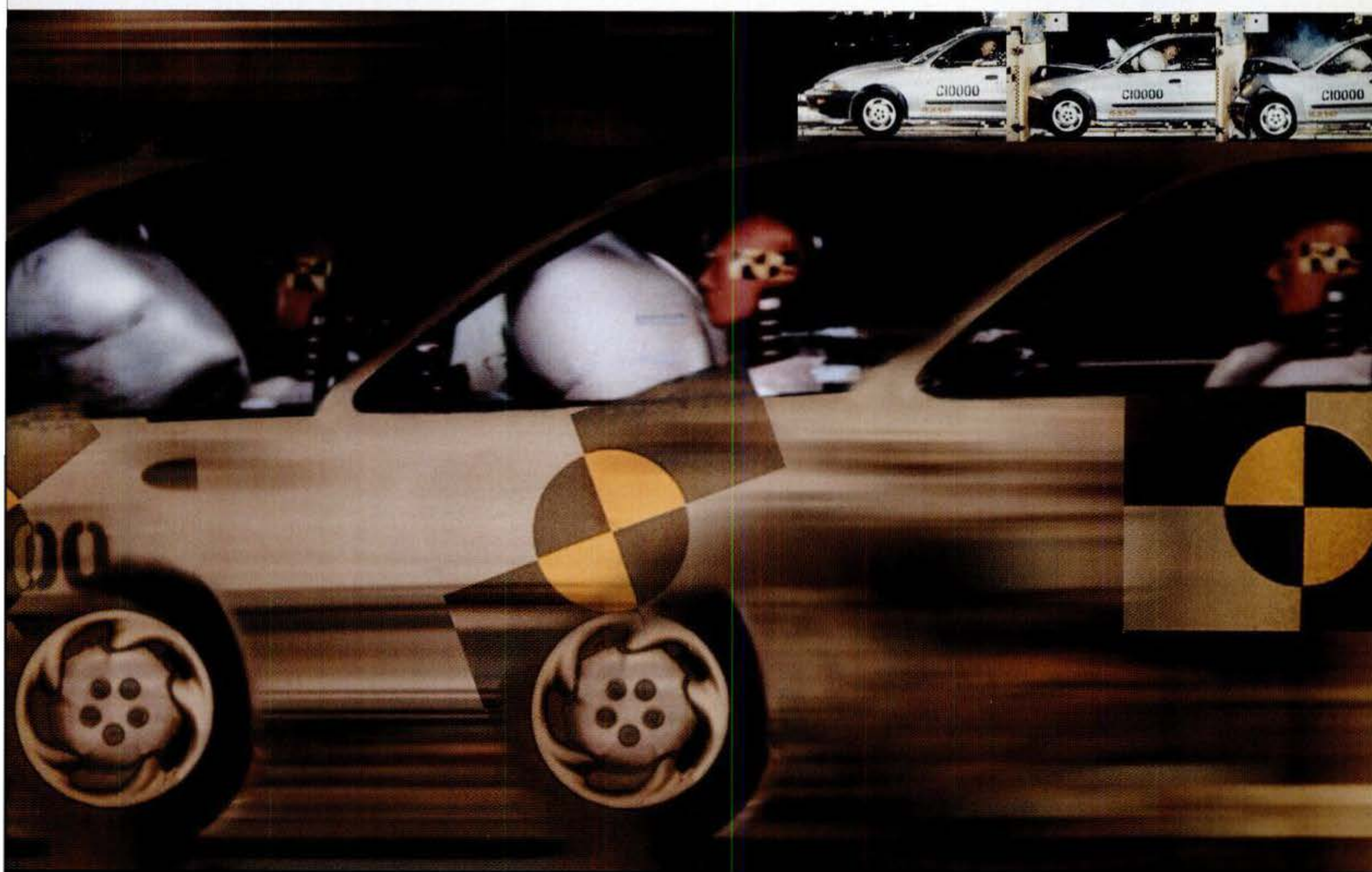
speed just shy of the sound barrier to a complete stop.

A physician and pilot in the early days of jet-powered flight, Stapp was using his own body to determine whether pilots could survive the forces of high-speed ejection. Strain gauges measured the impact of the deceleration on Stapp's tightly restrained body at some 40 times the force of gravity—the equivalent of a car running over his chest. As his face temporarily turned into Silly Putty, the strain began to detach the retinas from the backs of his eyeballs.

This stunning, courageous feat not only advanced the science of biomechanics; it eventually affected the design of everything from aircraft ejection systems to car interiors to football helmets. But the most pervasive idea that resulted from Stapp's work was his suggestion that perhaps cars, like airplanes, should also have seat belts.

Leap forward to today. The most technologically sophisticated component of a modern car's crash-survival system is the airbag. Suddenly, it has become car's most controversial feature as well.

Through last year, 52 people were killed by airbags in crashes they might otherwise have survived, according to a study by the National Highway Traffic Safety Administration (NHTSA). This fact may come as a shock to mo-



Force?

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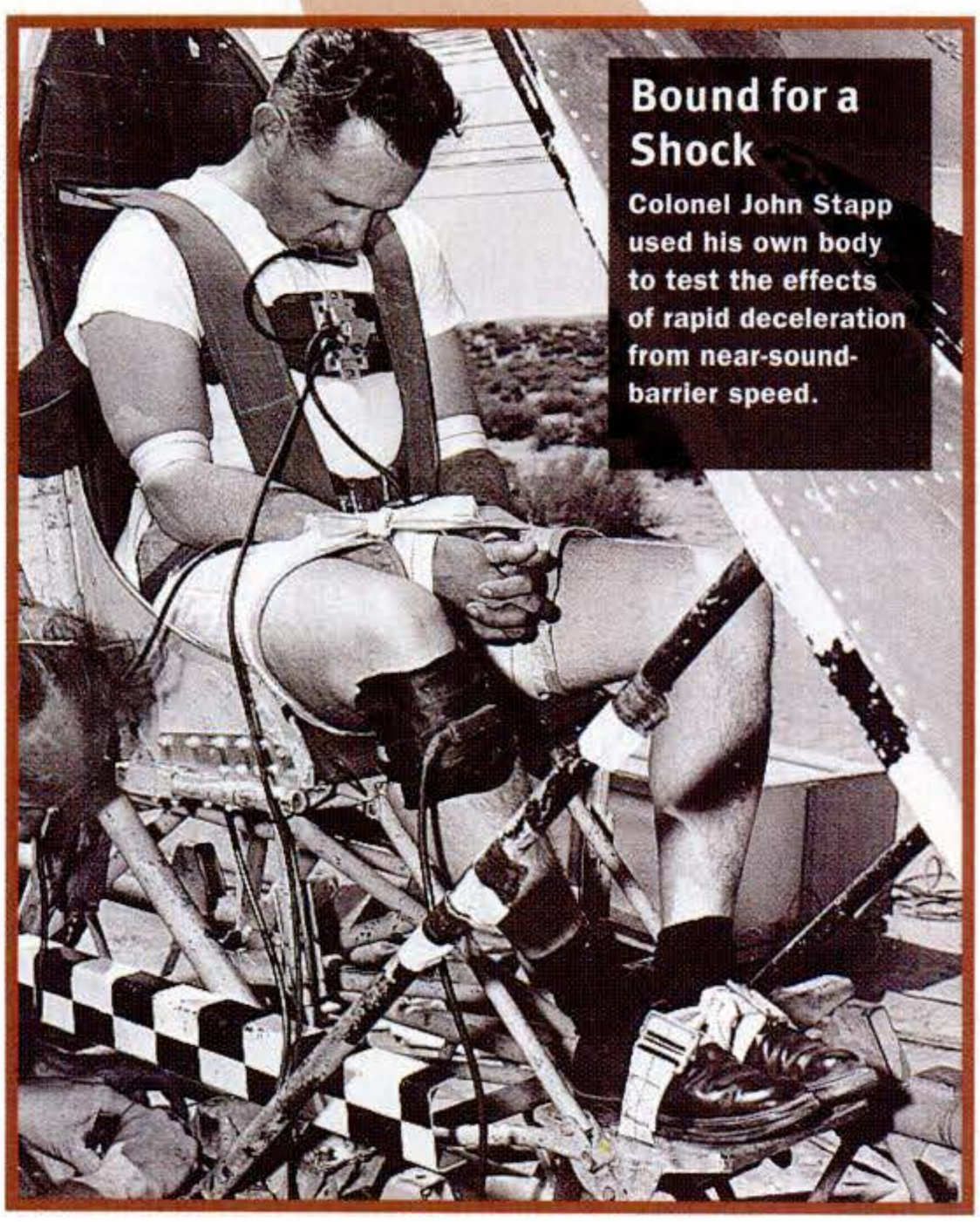
torists who view the airbag as a high-tech savior. Statistically, these fatalities occurred in a small portion of the estimated 50 million airbag-equipped cars and trucks on the road today, according to the Insurance Institute for Highway Safety. But a disproportionate number—32 of the total of 52—were children. Such studies and others have prompted a revised look at exactly what is expected of restraint systems.

The common conception of an airbag is of a kind of benign pillow that inflates to cushion the occupants as the car crumples around them in an accident. Such a view denies the realities of the energy unleashed in a car crash and obscures the primary strategy needed to survive one.

In assessing the impact of a crash on a driver or passenger, the human body becomes a study in structure; the skeleton is subjected to the kind of engineering analysis used to determine, say, the breaking point of an airplane's wing spar. The skull becomes a container of gels and fluids, the chest cavity a flattened, resilient, rib-walled cylinder with a remarkable ability to absorb lateral impact.

Stapp's work with the rocket sled, with strain gauges wrapped around his body, helped to quantify the little information known at the time about how the human body reacts to blows and stresses. Earlier work included interviewing people who had survived a jump or fall off the Golden Gate Bridge and studying autopsies of those who had died from such falls. Cases like these lend themselves to analysis because water provides a consistent surface, making it easy to calculate the velocity at impact.

Stapp's survival at a sustained 40-G deceleration is not too far off the mark from today's test-crash requirements. Federal frontal-impact standards now call for a maximum of 60 Gs on the chest of the crash dummy, for 36 milliseconds, while forces on the head sometimes reach 80 Gs.



AIRFORCE FLIGHT TEST CENTER

Bound for a Shock

Colonel John Stapp used his own body to test the effects of rapid deceleration from near-sound-barrier speed.

But in fact, the federal mandates were not developed as a direct result of Stapp's work. Of greater influence were a series of studies performed on cadavers and animals in the early 1970s. These studies eventually provided a more comprehensive database that quantified the mechanical strength of the human body. They also led to the development of crash-test dummies with built-in accelerometers, the basic measurement tool in crash testing. From these and other tests, a clear definition of the problem of surviving a crash has emerged.

Basic physics predicts that a body traveling at 30 mph and decelerating at 60 Gs will travel less than a foot before it stops.

With the maximum allowable force of deceleration a known quantity, the challenge to engineering is how to come to a smooth stop in that one-foot distance. But a real-world car crash is hardly smooth; it's more an exercise in chaos theory as sheet metal crumples, frames collapse, and the heavy mass of the engine and transmission is displaced. As a result, G-loads can "spike" to lethal levels as the structure crumples, unless the vehicle is carefully designed.

Bringing the passenger compartment to a halt is only part of the problem. Stopping the forward motion of the passengers is the ultimate goal.

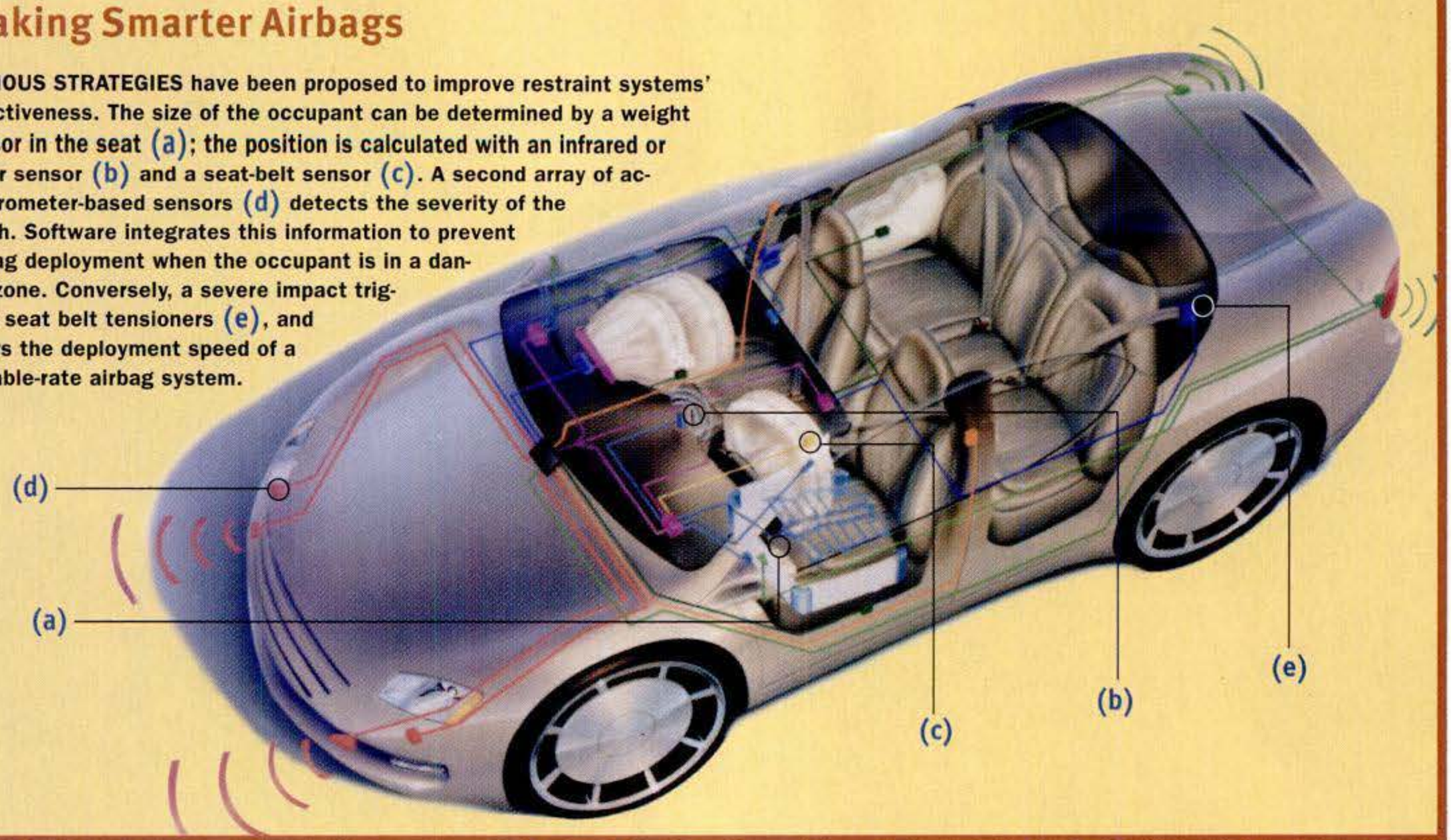
The seat belt, obviously, plays an essential role in achieving this. During a 40-G stop, a 200-pound man suddenly weighs four tons. His head alone is being pushed forward with a 400-pound force at the top of his spine. This isn't quite the equivalent of being run over by a truck: The short duration of the crash means the body isn't subjected to a sustained 40-G stress. Rather, the impact is more like a hydraulic shock, or sharp blow, to the body. Such a shock is survivable at higher G-loads—but these are difficult to predict, because of the spiking effect. Designed to collapse progressively, an efficient crush structure in a medium-size car can reduce that G-load significantly, but the strain on both the seat belt webbing and the human body are still tremendous.

An unrestrained occupant, however, simply doesn't stop, although the car does. The interior has sufficient space, about two feet between the head and steering wheel, for the mass of the occupant to maintain the full 30 mph speed while the steering wheel is coming to a halt, and the driver then hits it head on. Ironically, even after the car stops within calculated, survivable limits of deceleration, its interior becomes a solid, fatal barrier itself.

The problem posed by an unrestrained occupant was the original impetus for adapting the self-inflating airbag (an idea that began as a way to protect the occupants of early-generation space shuttles) to a car's interior. The airbag is a tough, self-inflating cushion that can expand quickly enough to meet the mass of the body halfway, then decelerate that body within survival parameters. To diminish the stress on the body, the bag accomplishes two objectives: It distributes the load broadly across its

Making Smarter Airbags

VARIOUS STRATEGIES have been proposed to improve restraint systems' effectiveness. The size of the occupant can be determined by a weight sensor in the seat (a); the position is calculated with an infrared or radar sensor (b) and a seat-belt sensor (c). A second array of accelerometer-based sensors (d) detects the severity of the crash. Software integrates this information to prevent airbag deployment when the occupant is in a danger zone. Conversely, a severe impact triggers seat belt tensioners (e), and alters the deployment speed of a variable-rate airbag system.



COURTESY: SIEMENS

surface and absorbs energy as it vents gas and collapses.

In the United States, however, the federal requirement calls for sufficient protection for a seated, unbelted 170-pound adult male dummy to "survive" a 30-mph frontal barrier crash. Intercepting a human body that's flying across the passenger compartment requires a force approximating the energy of the mass of the body. The earliest systems, larger and more forceful than those in use today, deployed with almost the same energy it takes to stop the car itself. Getting hit by an airbag was about the same as being hit by a big, soft car.

Although today's systems are smaller, the energy in the bag as it blows out of its container is still enormous. The danger zone is very close to the airbag. A recent NHTSA study with a child-size dummy showed that at distances ranging from directly on top of the bag to about four inches away, deployment produced enough force to cause serious, or even fatal, injuries. At about six inches away, the recorded force fell to what are considered acceptable levels, based on "injury" levels measured on the dummy.

Of the 32 deaths of small children reported in the NHTSA study, nine were caused by rear-facing infant seats positioned directly on the airbag when it deployed. Another common cause of death was an unbelted child—including some kids who were strapped in child seats that were not secured to the car—thrown onto the airbag by hard braking just before the crash.

The need to protect the unrestrained driver and passenger is at the heart of the newfound concern over the power of airbags. Automakers have requested an immediate change in the federal rules that would allow them to "depower" the system, arguing that reducing the force of the bag would not only protect small children and small adults (who are more vulnerable to the shock), but would also reduce the impact on the neck of a fully restrained driver when the bag deploys from the steering wheel. These moves, the automakers say, would enhance an airbag system's safety.

The controversy has prompted renewed interest in **so-called smart airbag systems that use sensors, either infrared or radar, to determine where the occupant is when the crash occurs,** and to alter the force of the bag accordingly.

The basic strategy is to develop a sensing system that lessens the power of airbag deployment when the occupant is sitting upright with his belt on. When the occupant is unbelted, the airbag is fully powered. The last, worst-case scenario occurs when the occupant is unbelted but in a hazardous position in regard to bag deployment. The system would sense this and turn the bag off. While many of these occupant-sensor features have been demonstrated, automakers are unsure of their reliability in the real world.

The irony is that after more than three decades of development, a truly "passive" system that covers all possibilities—ranging from a squirming child to an adult who leans or is tossed forward on top of the airbag—without including a seat belt does not exist. The seat belt is not only the primary system to absorb the energy of your body's forward velocity, it ensures that the occupant is in a predictable position when the crash occurs—essential to the maximum performance of the airbag.

So buckle up. The best chance for crash survival is based on a total system, including crush engineering, seat belt webbing, and airbags. Leaving one out of the equation is potentially lethal, and an unbuckled seat belt is an invitation to disaster. ◆

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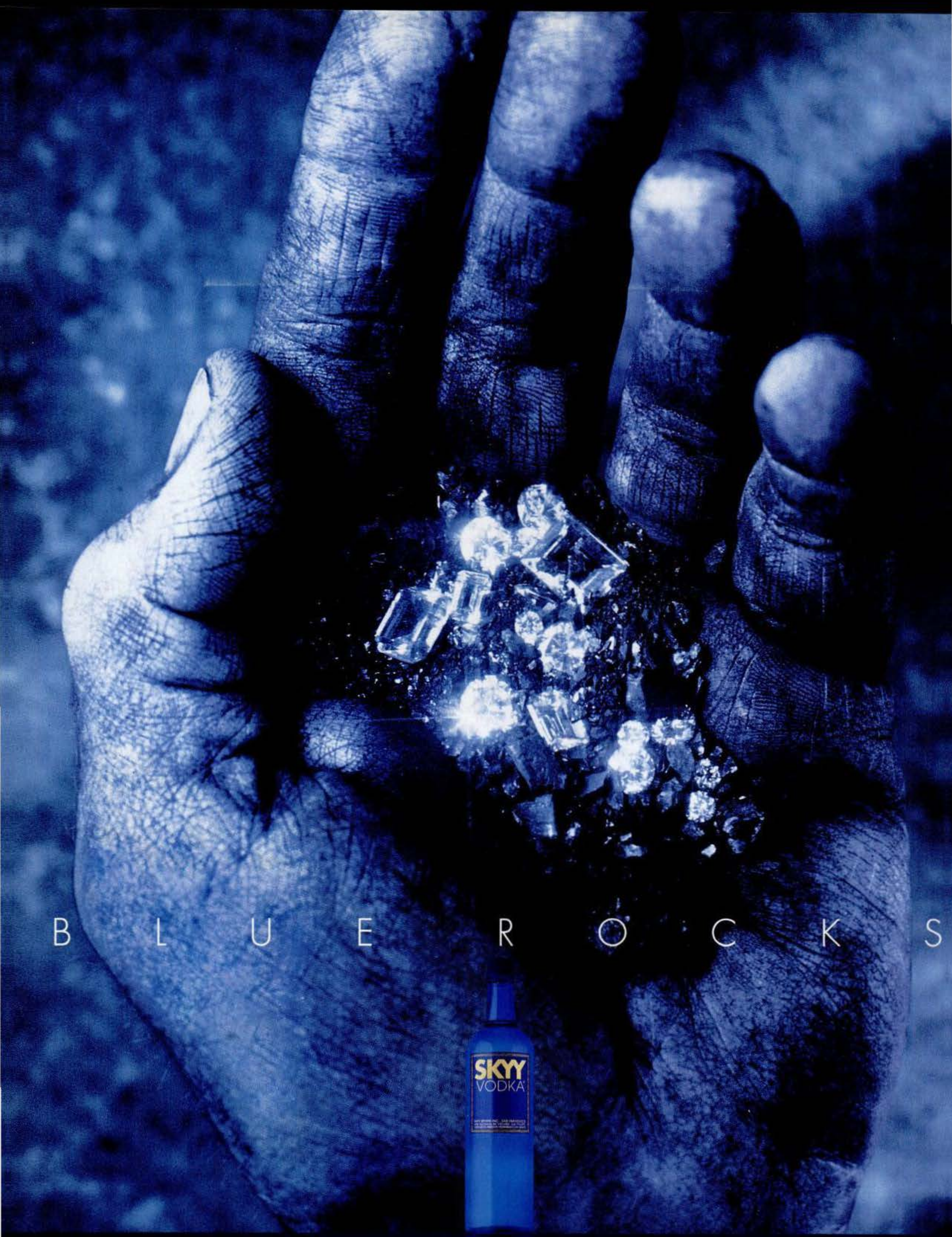

Pour two ounces of Skyy vodka over ice. Also known as Skyy Ice, Skyy Over, Skyy Rocks,

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ESSENTIAL TECHNOLOGY GUIDE

BEER, WINE & SPIRITS

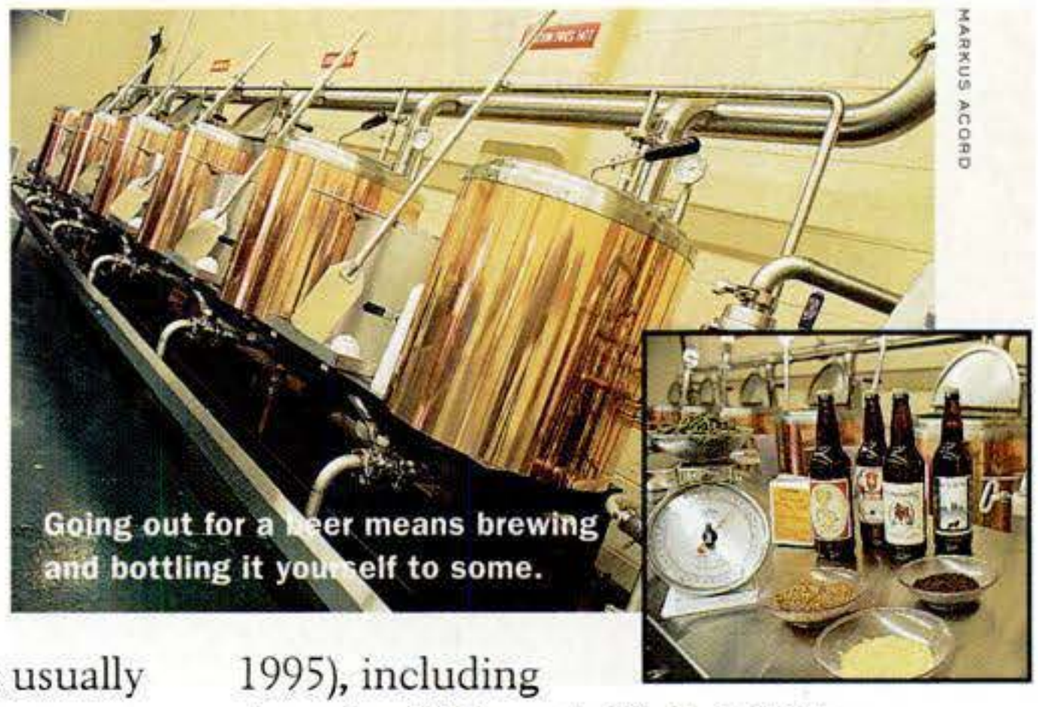
Alcohol, a colorless liquid composed of carbon, oxygen, and hydrogen (C_2H_6O), is the agent of influence in beer, wine, and distilled spirits. New technologies are affecting how it's made and served. And now science is saying it's even good for you. BY CHRIS O'MALLEY

Home Brew Takeout

IF YOU'VE EVER fantasized about creating your own beer—but were put off by the amount of time and money involved in home brewing—then you might be interested in a new alternative that's coming to a storefront near you, if it's not already there. It's called a "brew-on-premise" store, and its brand of social, no-commitment personal brewing is catching on across America.

For $100 to $150, a typical brew-on-premise store gives you everything you need to brew your own beer on the spot, including the recipes, ingredients, mixing gear, bottles, and tutoring. And they handle the cleanup. You will have to wait at least a few weeks before your beer is ready to drink, but you can design a custom label for your brew in the meantime. The home-brew haul is usually four to six cases of beer. Most stores offer a variety of lager and ale styles to choose among.

About 55 brew-on-premise establishments are already open in the United States (up from eight in 1995), including America U-Brew in Philadelphia, The Beer Store in Denver, and Brew City in San Francisco. About 20 more are expected to open this year, according to Diana Shellenberger, an editor with *New Brewer Magazine*.



MARKUS ACORD

Going out for a beer means brewing and bottling it yourself to some.

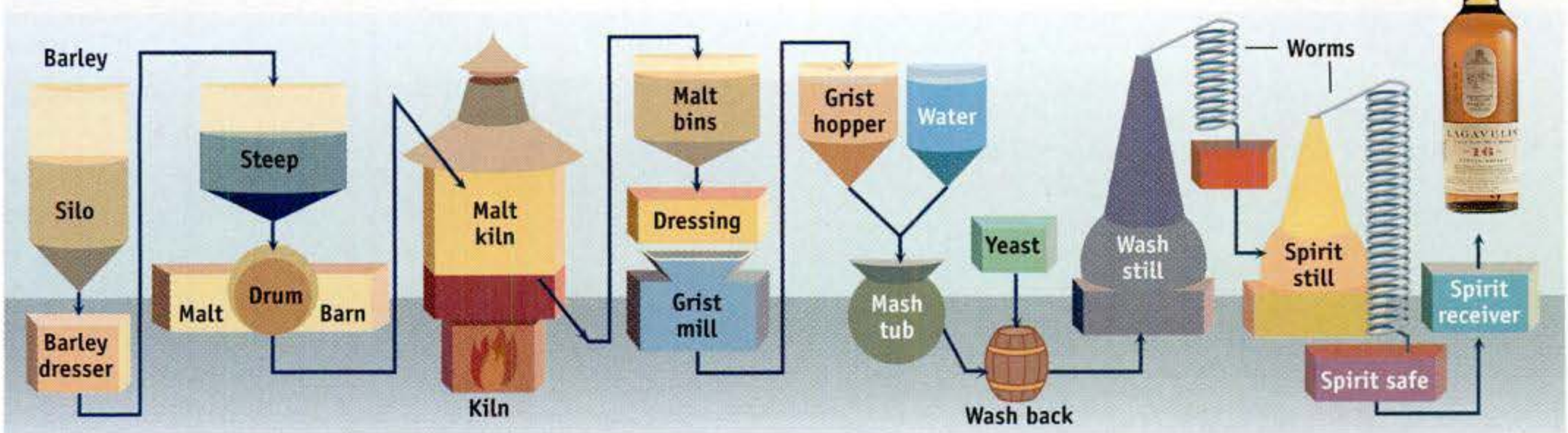
The Lone Malt

THERE MAY BE no tribe of imbibers more loyal to their libation than drinkers of Scotch. And increasingly, it's the more strongly flavored "single-malt" variety of Scotland's whiskies that pleases their keen palates.

Unlike a blended Scotch—essentially a mix of bland, inexpensive grain whiskies (distilled from ordinary grains) and tastier, pricier malt whiskies (made from malted barley in copper contraptions known as pot stills)—single-malt Scotch is 100 percent malt whiskey from a single Scottish distiller.

Dozens of single-malt Scotches are now available, and their taste can vary greatly, depending upon which part of the country it hails from—a whiskey from the Highlands will taste different from one that comes from the Isle of Skye, for example. The whiskey's age (eight to 25 years), also influences the taste—making it smoother. Unsurprisingly, age has a price (as high as $200 a bottle).

REBECCA PERRY



Single-malt Scotch is made in four stages: malting, brewing, distilling, and aging. Malting turns partially germinated barley into malt grist in a peat-fired kiln. Brewing turns the grist into an alcoholic liquid, which then gets distilled in copper kettles.

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Draught in a Can

WANT A FRESH, foamy draft beer? Pop open a can. As unlikely as that prospect sounds, several Irish and British brewers are making canned beer taste like kegged—and bottles that mimic kegs are on the way.

Guinness launched the draft-in-a-can trend in 1989 with a version of its stout called Pub Draught Guinness. Its scientific secret: A hollow plastic insert—better known in the industry as a widget—wedged into the bottom of the can gets dosed with liquid nitrogen. When you pop the top, the depressurization prompts thousands of nitrogen bubbles to float to the top, bringing with them the thick, creamy head that Guinness lovers expect of a good "pull" from a keg.

SLIM FILMS

Guinness is no longer alone in the widget business. Aston Manor, Bass, Courage, Scottish & Newcastle, Whitbread, and others have developed widget variations of their own. (No U.S. brewers have attempted it yet.) And bottle versions were recently developed by several brewers. Whitbread's new bottle uses a floating capsule with valves to nitrogen-charge its brew, while Aston Manor uses a squeezable plastic bottle that has a device fitted into its neck to force beer out a small opening. An under-the-bottle-cap design has already been patented, too.

And the taste? We found that the Guinness stout, while not quite the equal of a freshly tapped keg from Dublin, is consistently good.

Alcohol Be Gone

SO HOW DO they remove most of the alcohol from nonalcoholic brews? It's done in one of four ways:

- Heating. Alcohol evaporates at lower temperatures than water, so simmering an alcoholic beer can boil away most of the alcohol.
- Vacuum Distilling. A variation of the heating method, this is done in an airless setting to more gently vaporize the alcohol.
- Filtering. Alcohol is removed by passing beer through a membrane, either under pressure (reverse osmosis) or not (dialysis).
- Arresting Fermentation. Brewing at cold temperatures and/or using "low-efficiency" yeasts can yield little alcohol during fermentation.

When to Say When

THE RATE AT WHICH you reach intoxication depends on a range of factors, including your health and how much you've eaten. The legal limit for driving in most states is .08 or .10. Here are some guidelines.

Blood Alcohol Concentrations after **Three Drinks***

Weight	110	120	130	140	150	160	170
1 hr	.126	.114	.104	.095	.088	.081	.071
2 hrs	.110	.098	.088	.079	.072	.065	.055
3 hrs	.094	.082	.072	.063	.056	.049	.039
4 hrs	.078	.066	.056	.047	.040	.033	.023

Blood Alcohol Concentrations after **Four Drinks***

Weight	140	150	160	170	180	190	200
1 hr	.108	.099	.092	.086	.080	.071	.066
2 hrs	.092	.083	.076	.070	.064	.055	.050
3 hrs	.076	.067	.060	.057	.048	.039	.034
4 hrs	.060	.051	.044	.038	.032	.023	.018

*standard drink equals one 12-ounce beer, one five-ounce glass of wine, or one and a half ounces of 80-proof liquor.

©Moderate Drinking by Audrey Kishline, 1995

Wine for the Heart

CAN A GLASS of red wine a day keep the cardiologist away? Maybe, but recent studies suggest it may the alcohol, not the grapes, that help prevent heart disease, meaning that moderate amounts of beer and distilled spirits could have the same effect.

The phenomenon known as the French paradox—specifically, their bent for fatty foods and red wine, yet relatively low rate of heart disease—gave rise to speculation there was something about red wine that was good for the cardiovascular system. One prominent theory holds that naturally occurring compounds called "flavonoids" in red wine or even grape juice may reduce the stickiness of blood-clotting cells known as platelets.

But many recent studies suggest it's the alcohol—in any form—taken in one or two drinks daily that may do you some good, perhaps by raising the level of high-density lipoprotein (HDL) cholesterol, the "good" cholesterol that reduces buildups on arterial walls.

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Fresh or Foul?

DOES A "best used before" or "born on" date on a beer bottle label guarantee you a fresh brew? Not necessarily. While plain-English freshness dates are a useful tool to ensure your beer hasn't been sitting on a store shelf too long, other factors—notably brewing techniques and storage temperature—can have a big impact on beer freshness.

Beers that are fully pasteurized, as most national brands are, have a shelf life of three months, in cans or bottles. But many more flavorful craft brews are "flash" pasteurized for only a minute, or passed through a sterilizing filter instead. That can reduce shelf life. Once beer is pasteurized, heat is an enemy—as is sunlight.

Dates are nice but they are no guarantee.

DWI: Tougher Test Hits the Road

THINK IT'S UNLIKELY you'd ever be nabbed for driving under the influence? Think again. Thirteen of the 48 states that use blood alcohol levels to judge intoxication have lowered their legal limits to 0.08 percent, down from 0.10. And the National Highway Traffic Safety Administration is prodding other states to do the same—or have Congress do it for them. Still, by most reckonings, a man weighing 170 to 180 pounds would have to drink four beers, or perhaps two generous martinis, in one hour to reach the 0.08 level.

The Morning After

THERE IS NO such thing as a hangover "cure," aside from not drinking. But thanks to medical science, we do know what's happening inside your beleaguered body the morning after—and a bit about steps to take the night before to lessen drinking's impact. Some scientific rules of thumb:

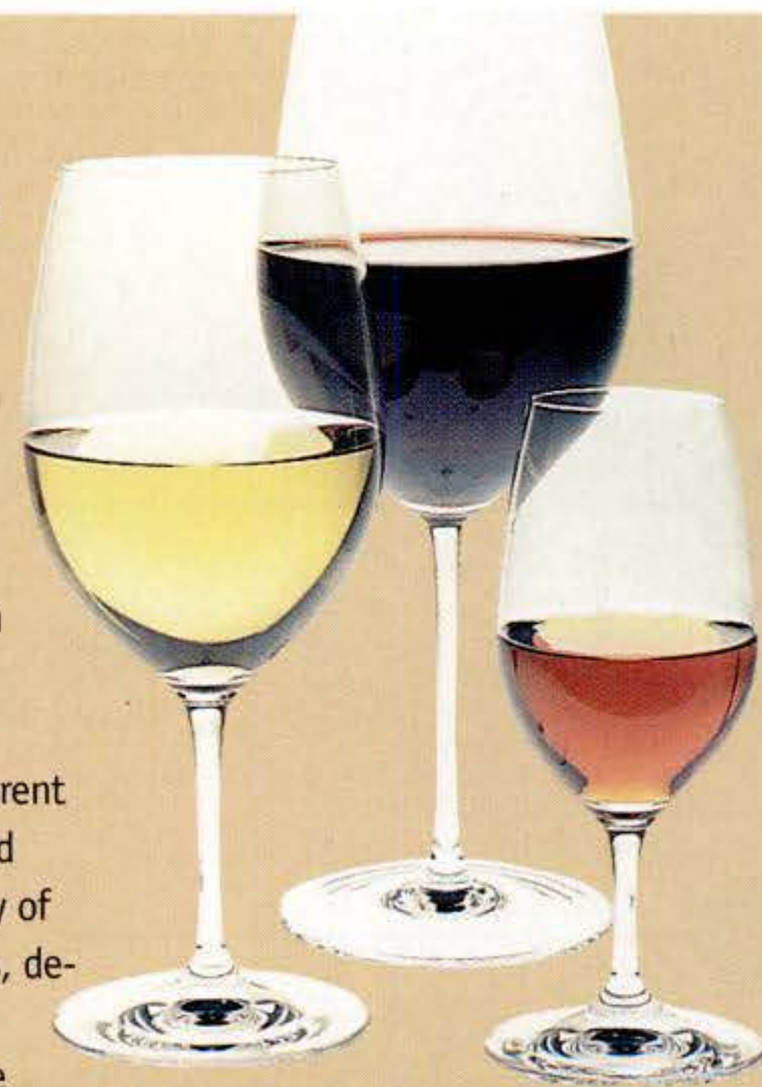
1. **Pace yourself.** Your body converts alcohol to acetaldehyde, which is the substance that's primarily responsible for a hangover later on. And your body can process about one drink's worth of the stuff per hour.
2. **Pick your poison—and stick with it.** A 12-ounce beer, a five-ounce glass of wine, and a shot of whiskey all have roughly the same half ounce of pure alcohol. Sticking with the same drink may help prevent an upset stomach, but not drunkenness.
3. **Have a meal first.** Even a glass of milk will slow down the effects of alcohol consumption.
4. **Drink a pint of water, and take aspirin if you can tolerate it, before hitting the hay.** Dehydration is a major source of next-morning discomfort. The aspirin will simply help minimize the headache.
5. **Clip the hair of the dog.** Another drink will only help if you're an addict suffering withdrawal symptoms, in which case you've got bigger problems than a hangover.

Meanwhile, staffers at POPULAR SCIENCE have their own favorite cures. Among them are: a chocolate shake, miso soup, ginger ale, a bagel and cream cheese, Chinese food, and a greasy breakfast. And, of course, a cup of black coffee.

The Perfect Glass

THE NEXT time you're looking for a great wine experience, you might want to spend less time selecting the wine and more time picking the perfect wine glass. How long could that take? Maybe hours, particularly if you're choosing Austrian glass-maker Riedel's extensive collection of fine wine glasses.

Riedel sells more than 45 different wine glasses of varying shapes and sizes. Why so many? The geometry of every wine glass, the theory holds, determines which of the tongue's four taste zones (sweetness at the tip, acidity along the sides, saltiness at the edges, and bitterness or astringency at the back) the wine will reach first, linger upon, and create a taste impression upon when the glass is tipped. A slightly tapered glass will tend to direct wine to the center of the tongue to balance the fruity and moderately acidic qualities of a chardonnay, for example.



Picking the right wine glass may be as important as selecting the wine.

These vino vessels are not priced like your average burgundy balloon, either. Prices range from about $8 to more than $80—apiece—for the most popular styles. The Sommelier series glasses are mouth-blown by Riedel artisans while the less costly Vinum glasses are machine-blown.

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Beer's Civilizing Influence

THE FIRST BEER drinkers apparently changed the course of history.

The evidence now seems compelling that beer was instrumental in man's transition from nomadic hunter-gatherer to rooted farmer. "It's true: Mankind was lured by intoxication into tending crops and establishing settlements," says Alan Eames, a noted beer historian and author of *The Secret Life of Beer*.

There is substantial anthropological proof that beer brewing dates back at least 8,000 years to Egyptian societies, according to Eames, and possibly even 50,000 years or more.

RICHARD BECKERMAN

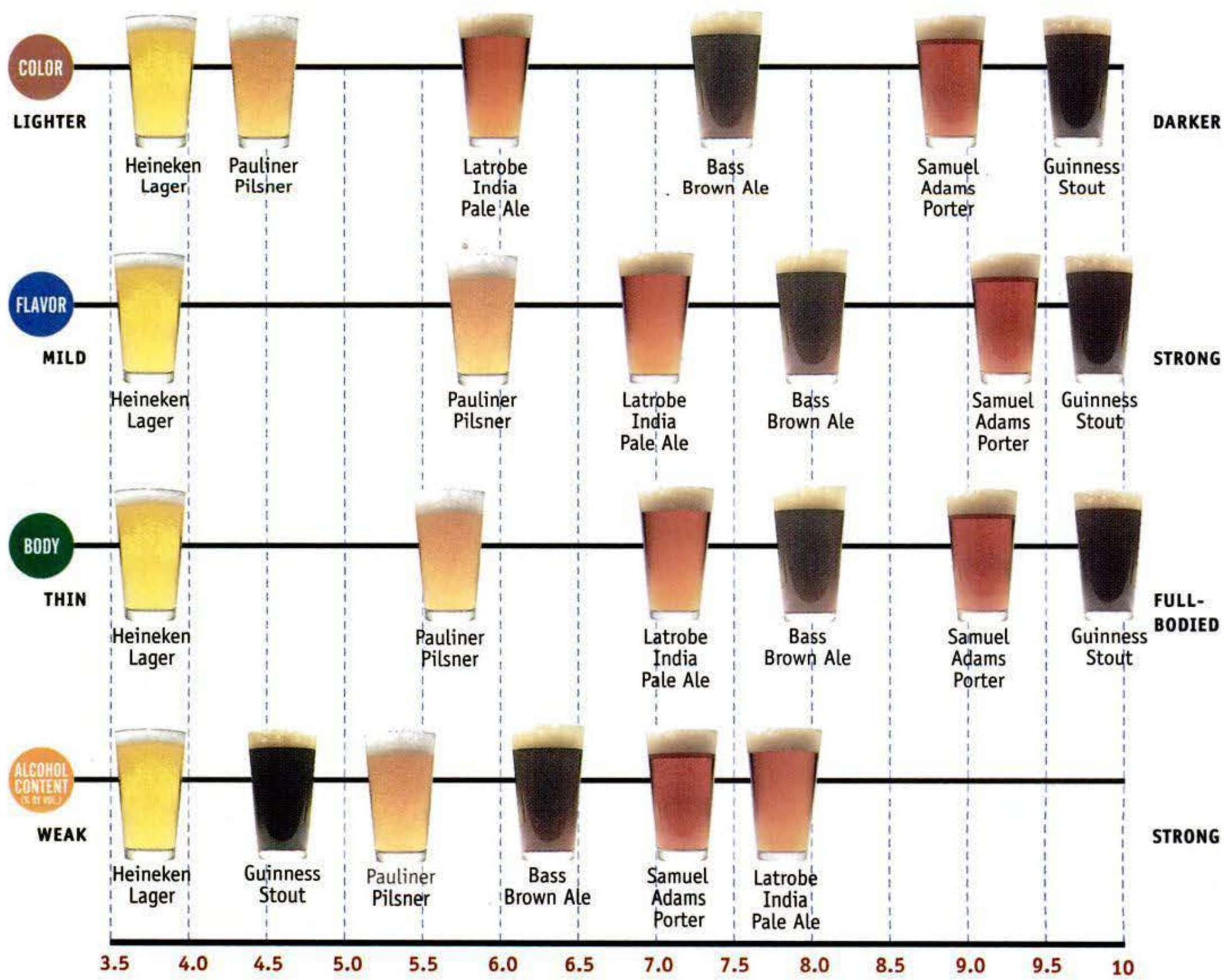
Shaken or Stirred?

ONCE AND FOR ALL: Is the perfect martini to be shaken or stirred? Despite literary protestations from Ian Fleming's James Bond (who insisted on shaken, because stirring "bruises the gin") and author Somerset Maugham (who insisted on stirred, because the gin and vermouth molecules should "lie gently upon each other"), the truth is it's more mental then molecular.

"It's all fiction," says Paul Pacult, editor of *The Spirit Journal* and professional taster.

Popular Science's Essential Beer Gauge

MOST BEERS are categorized as lighter-tasting lagers or more robust-tasting ales. But these categories have given rise to dozens of subcategories. What beer might suit your palate? Here are how a few popular styles pour:



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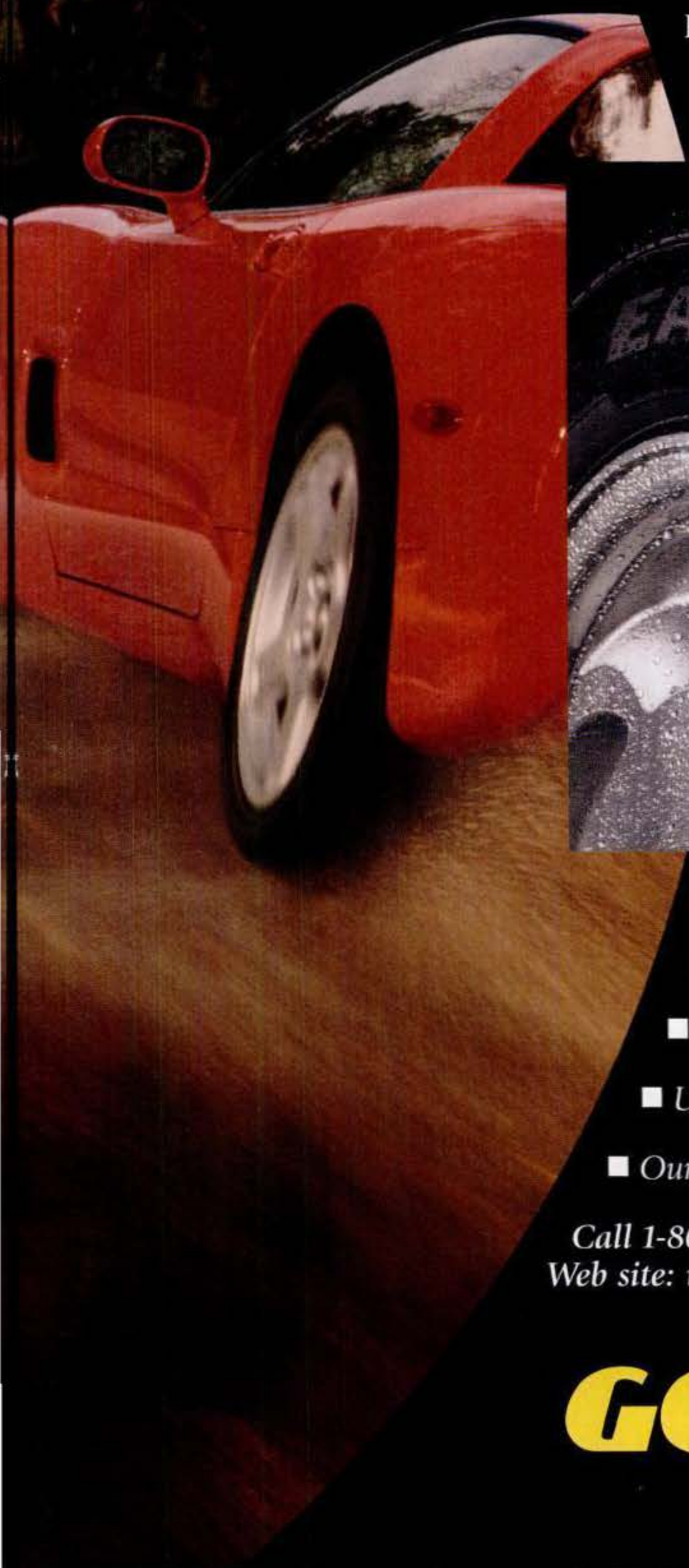

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ASK POPULAR SCIENCE

What are the chances of an Internet collapse, as has been rumored?

Will Decker
zxc89@ttacs1.ttu.edu

SLIM—DESPITE SOME sensational reports to the contrary. There are many reasons why the Internet will survive and adapt to its fast growth, including the fact that so many companies, organizations, and individuals now have a stake in its progress. But there are several technical reasons to be optimistic as well.

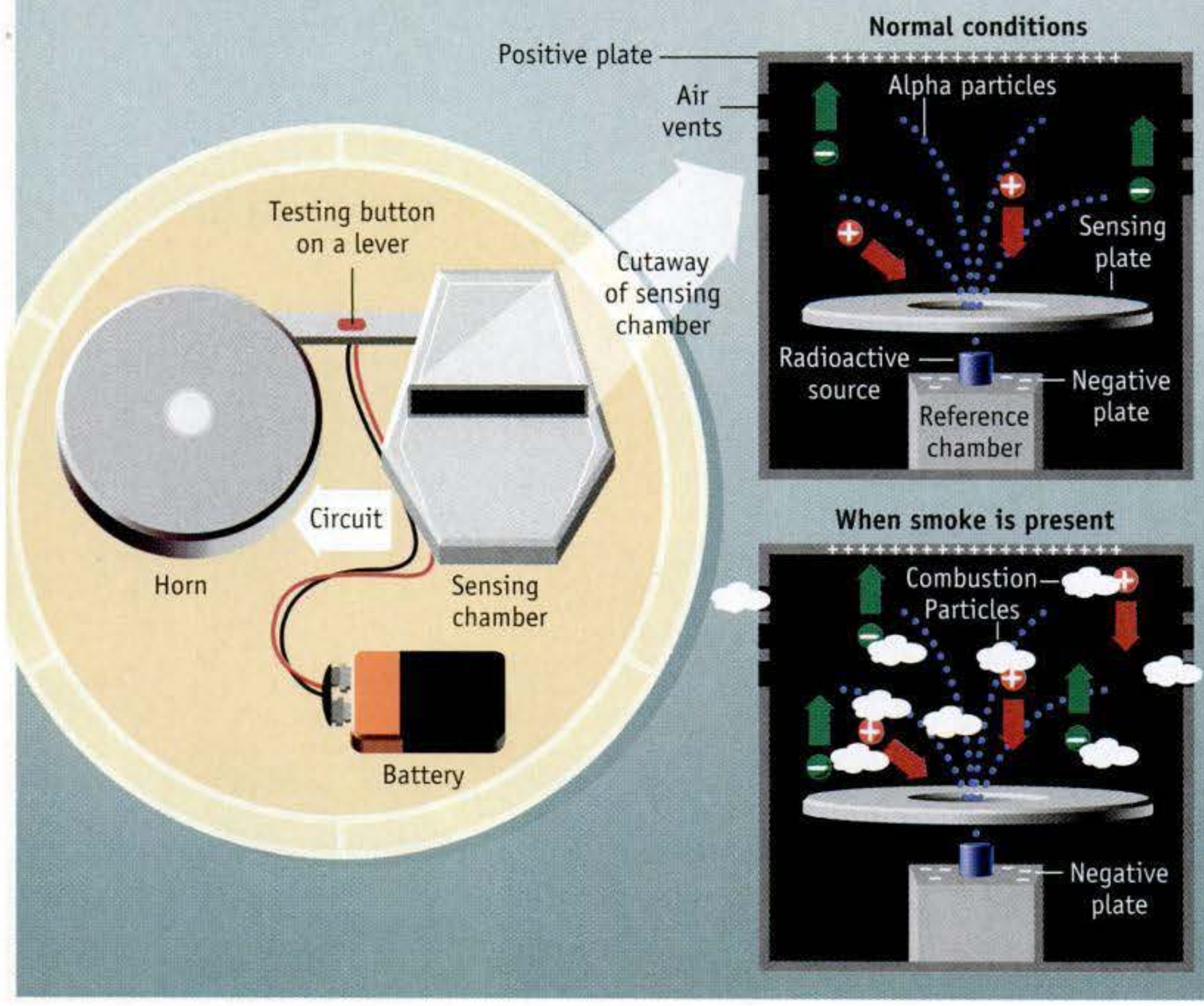
First, congestion is not the problem it might seem to be. A recent study by the World Wide Web Consortium, a standard-setting industry group, concluded that the basic software used by the Web—the Internet's most popular avenue—is responsible for many of the Web's delays, not the number of people accessing it. A redesign of that software, which is expected to appear in Web browsers

HOW IT WORKS

Household Smoke Detector

MOST STATES REQUIRE smoke detectors in both new and existing homes; 15 states mandate that such alarms be directly wired to a home s electrical system. Most smoke detectors, like the one that s shown below, work by a process called ionization, in which air molecules become electrically charged. These detectors usually cost less than $10. Another type, called a photoelectronic detector, makes use of a beam of light; when smoke particles refract or reflect this light, the unit sounds an alarm. Photoelectronic detectors cost from $10 to $20. Ionization detectors are usually best at sensing the tiny particles of combustion produced by fast-burning fires, while photoelectronic detectors tend to do a better job at detecting larger particles from smoldering fires.—*Judith Anne Gunther*

ALEX REARDON



1 In the sensing chamber, a radioactive source, americium 241, emits alpha particles that collide with air molecules, which gain or lose electrons and become electrically charged.

2 The positively charged molecules are attracted to the negative plate, while the negatively charged free electrons are attracted to the positive plate. As the electrons move about, they pass by the sensing plate and create a current.

3 When smoke enters the sensing chamber, the combustion particles also become electrically charged by the radioactive source. Some of the electrons recombine with these ionized particles, rather than moving toward the positive plate.

4 The sensing plate then detects a drop in the electrical current and sends a signal to the horn to sound the alarm.

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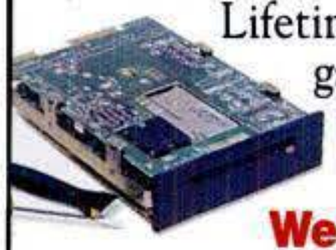

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It'll answer your questions too! Whether you want to start a business of your own or just want to make extra money in your spare time. It shows you how to do it in a field you enjoy. It even tells you how to make good money while you're training at home, in your spare time.

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6 TV/Satellite Dish Repair. Service the wave in entertainment. Make top dollar installing and repairing satellite dishes and the super-popular mini dishes.

7 Gunsmithing. Skilled gunsmiths charge up to $50 an hour for repairs. Work part-time, full-time or open your own shop.

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9 Upholstery. As furniture prices rise and quality noticeably decreases, it makes good sense to pursue a career in upholstery.

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later this year, could make data retrieval two to eight times faster than it is today.

Customers of rapidly growing services, most notably America Online, have experienced busy signals, largely from additional usage spurred by offers of unlimited Internet access time. These services are adding additional phone lines and modems at a rapid clip, however.

As with any hot-selling product, the pace of the demand will eventually slow. Meanwhile, online networks continue to expand. Moreover, many large service providers, including newly deregulated phone and cable TV companies, are still coming online, bringing additional capacity.

In addition, many of the Internet's most demanding and bandwidth-hungry applications will be moving to a new high-speed network known as Internet II. Many of the country's leading university and government research centers will soon begin using this alternate highway, rather than the public freeway that today's Internet has become. That, in turn, will leave more resources for the original Internet.

Doomsday scenarios tend to assume not only a continuing boom in the Internet's popularity, but also that the technology used to access it will remain fairly static. Recent history suggests otherwise. Modems keep getting faster and more efficient—as evidenced by the arrival of 56Kbps modems—and so do the computer servers that process Internet requests. The basic pipeline into most homes, analog phone wires, may not change quickly, but higher-capacity data services via digital phone lines, cable TV boxes, and satellite dishes are all expected to be available to residential customers within the next one to three years.

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Why is heat visible above a wood burner or camp fire?

Ryan Gajewski
Shawano, Wisc.

THE EFFECT YOU see above a wood-burning stove or a fire is the same one that causes mirages of shimmering puddles to appear as you're driving along hot highways. [See FYI, March.] Usually, denser, colder air sits below warmer, less dense air. But when a hot surface such as a wood stove or an asphalt road baking in the sun radiates its warmth to the air directly above, it creates a layered effect, with the warm air *below* the layer of colder

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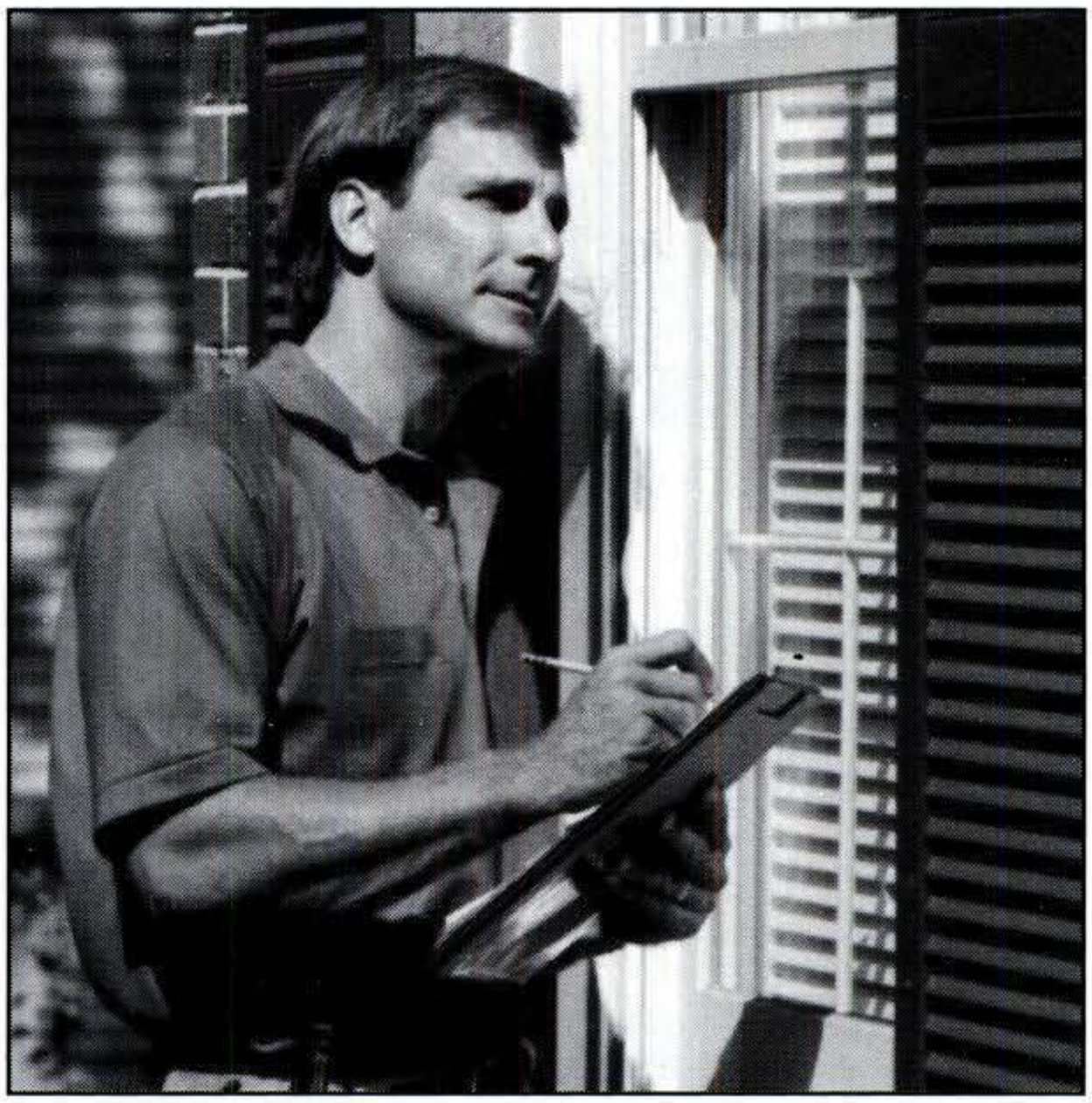

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• Sunday, April 20, 11:30 a.m.

THE LATEST ULTRASOUND
DR. ROY FILLY, professor of radiology at the University of California at San Francisco, shows off the capabilities of the most advanced new ultrasound machine, the Sequoia.

• Sunday, April 27, 11:30 a.m.

FUTURE FOODS
NASA'S JOHNSON Space Center is working to create foods that could last several years—long enough for extended space missions, or even a trip to Mars. Sounds delicious.

• Sunday, May 4, 11:30 a.m.

SPY TECH
EARLY IN each James Bond movie, 007 is invariably briefed by "Q," the expert on the latest high-tech gadgets available. We travel to London to meet Mike Phillips, a real-life Q who actually sells such cool spy gear at his Spy Catcher store.

• Sunday, May 11, 11:30 p.m.

HOW TO SPEAK "WHALE"
JOHN FORD is a biologist and pioneer in killer-whale dialect research. Using the latest audio technology, such as underwater recording equipment, he's assembling a computer data system to analyze whale sounds and their meanings.

air. The boundary between these two layers acts as a lens that bends the light rays and causes the heat to become 'visible.'

What's the difference between the new MMX processor and regular Pentium processors?

Steve Swain
sswain@aol.com

MMX IS SIMPLY a new type of Pentium microprocessor that handles audio, video, and graphics tasks better than the original Pentium chips. The term MMX—which originally stood for "multimedia extensions" but now stands for nothing in particular, according to chipmaker Intel—specifically means that 57 multimedia-centric instructions have been added to the basic "instruction set" that drives all Pentium processors.

Underlying these new instructions is a processing trick known as "single instruction, multiple data," which enables an MMX chip to package and process many pieces of information as one value, rather than in the one-at-a-time sequence that's known to cause bottlenecks. With these improvements, an MMX chip processes demanding multimedia tasks such as full-motion video and 3-D graphics more quickly and smoothly. One caveat, however: While older programs work fine on Pentium MMX systems, they can't take advantage of the new microprocessor's features. Software must be written, or rewritten, to reap MMX's benefits.

How can WebTV devices connect you to the World Wide Web, yet keep you from accessing the rest of the Internet?

Roger Mindel
mindel@smart.net

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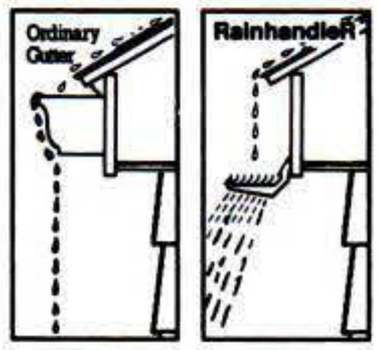

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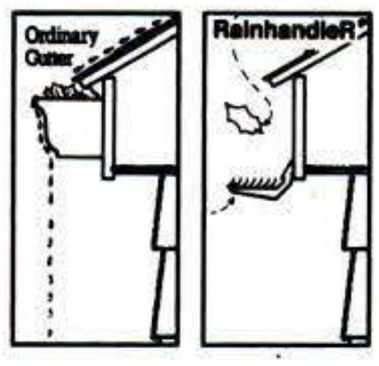

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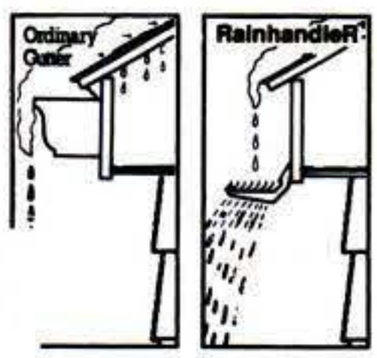

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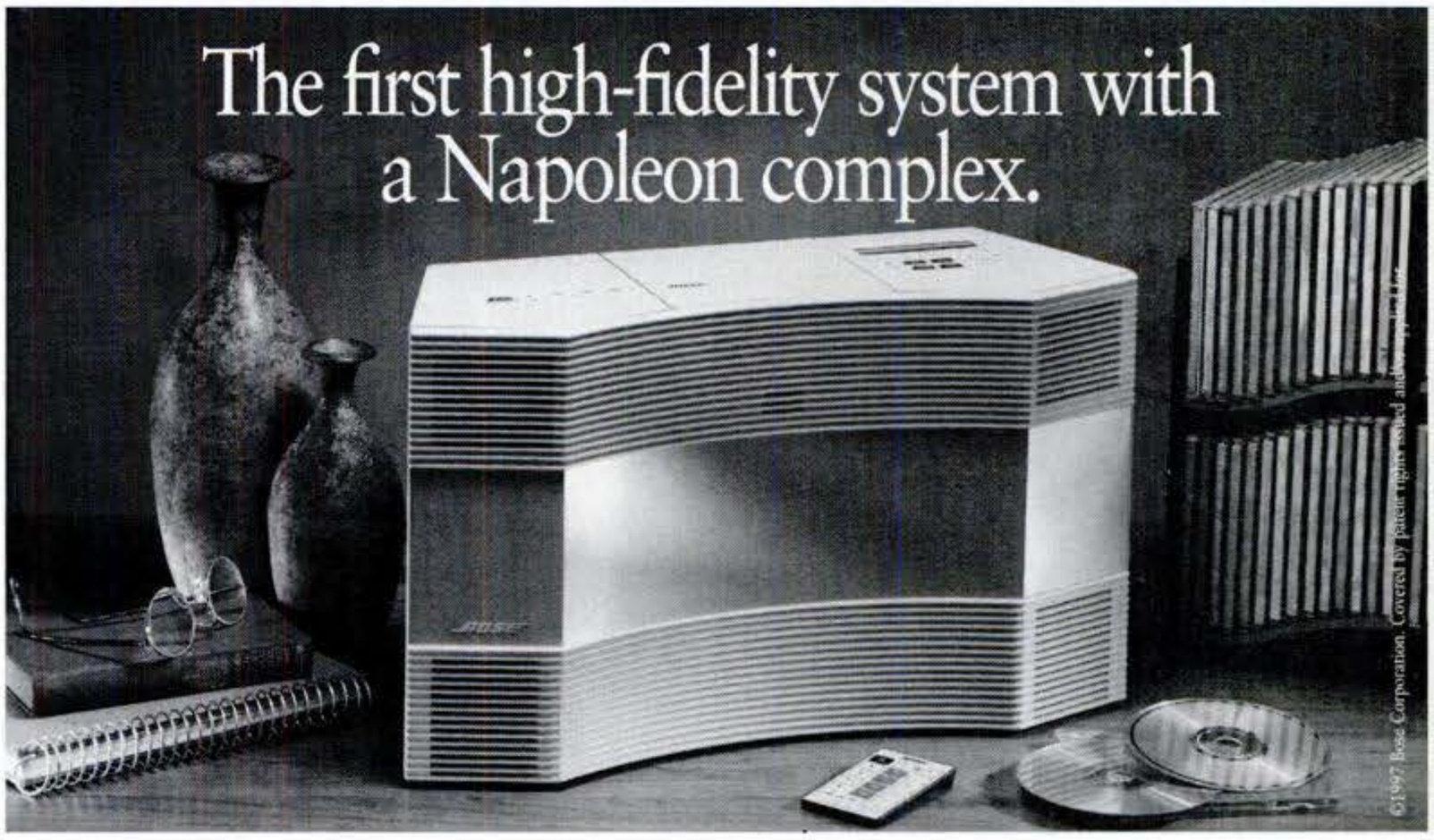

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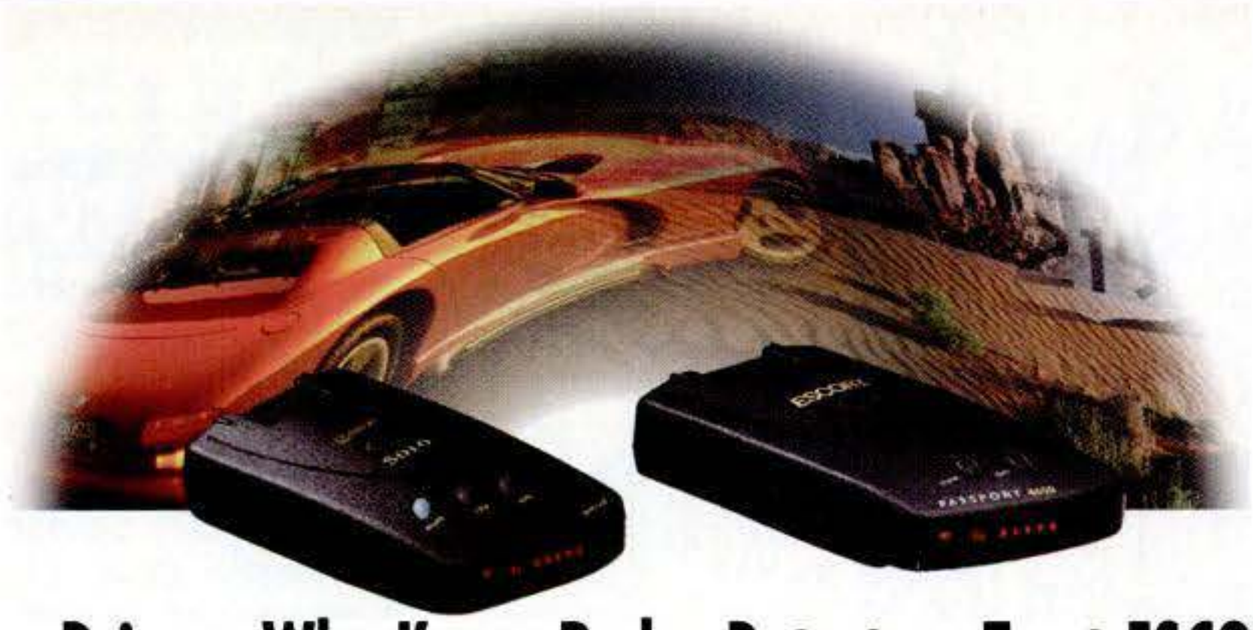

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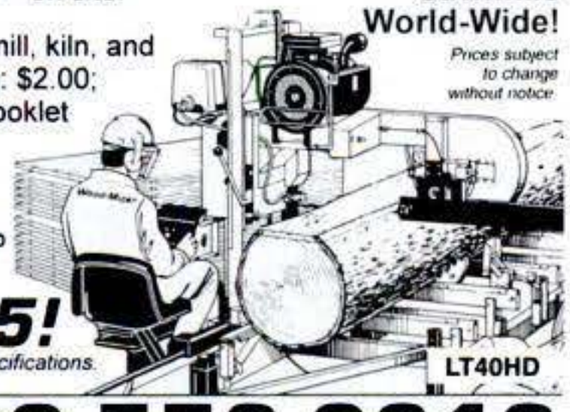

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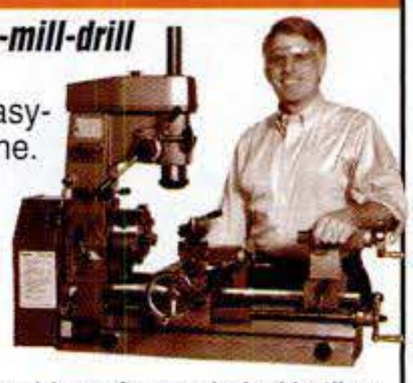

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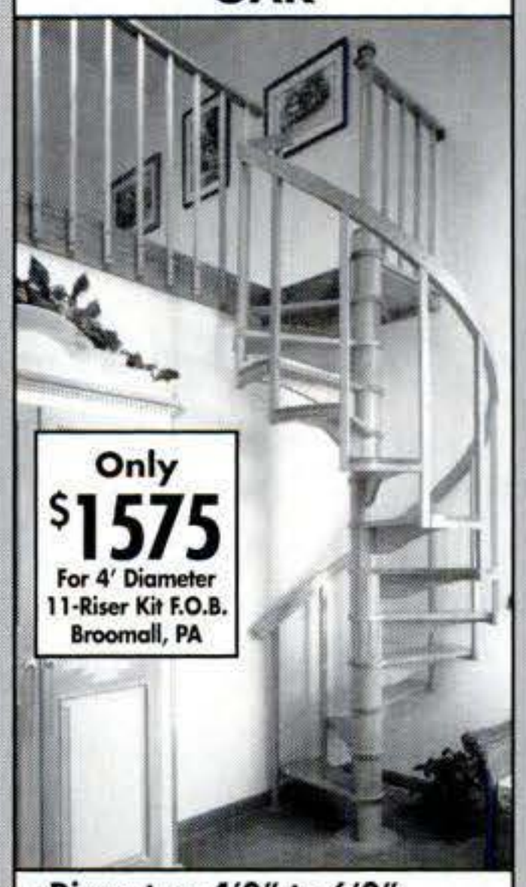

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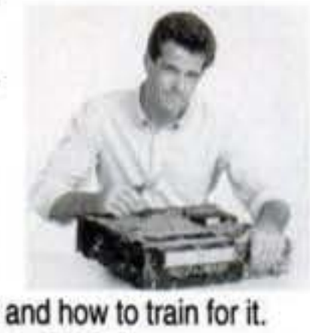

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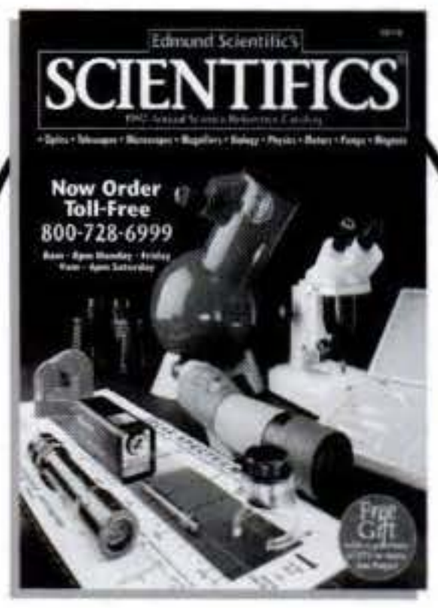

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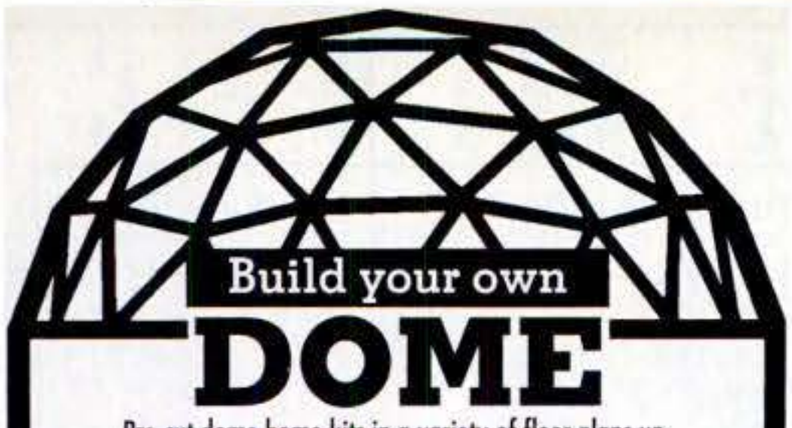

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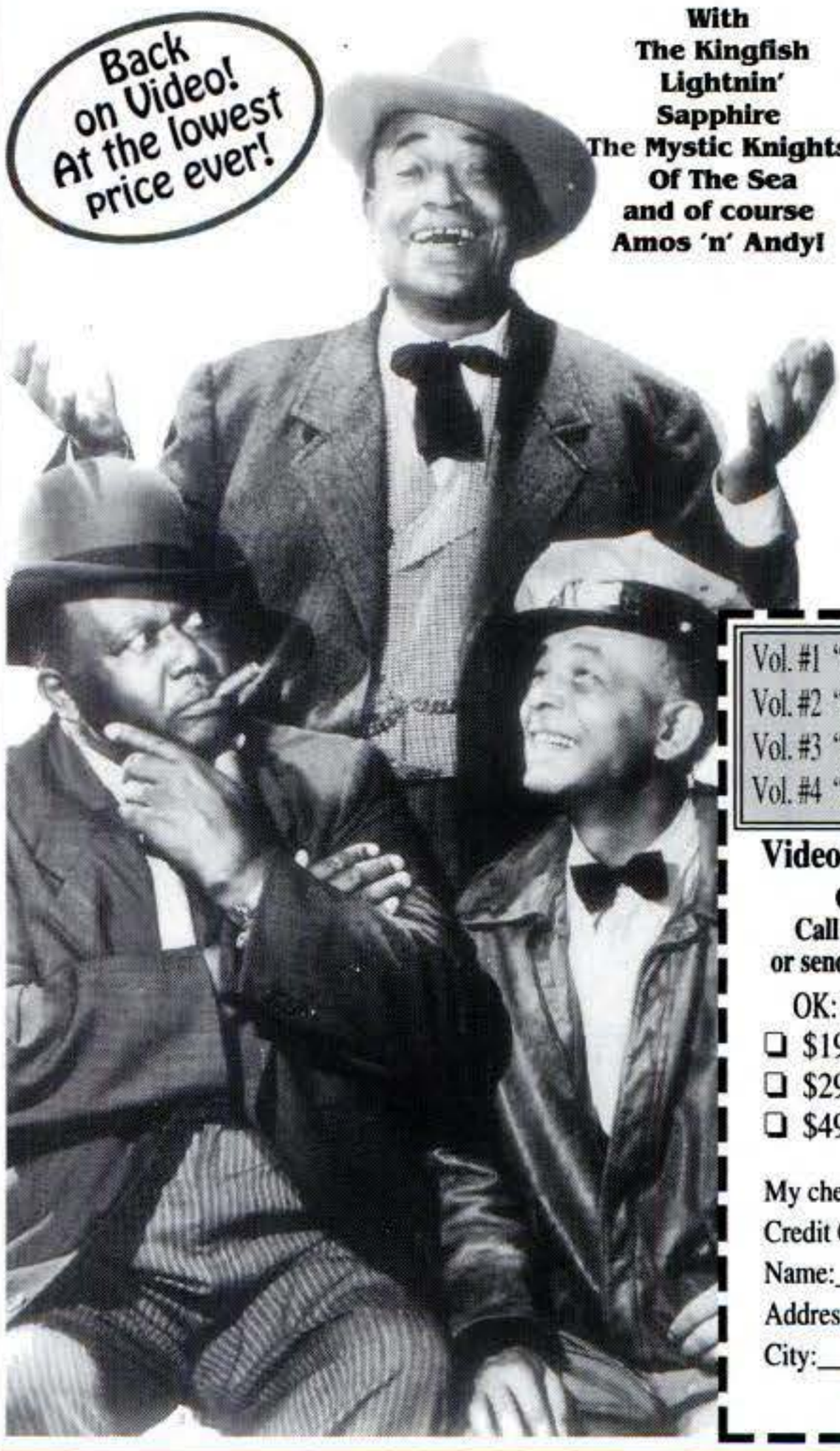

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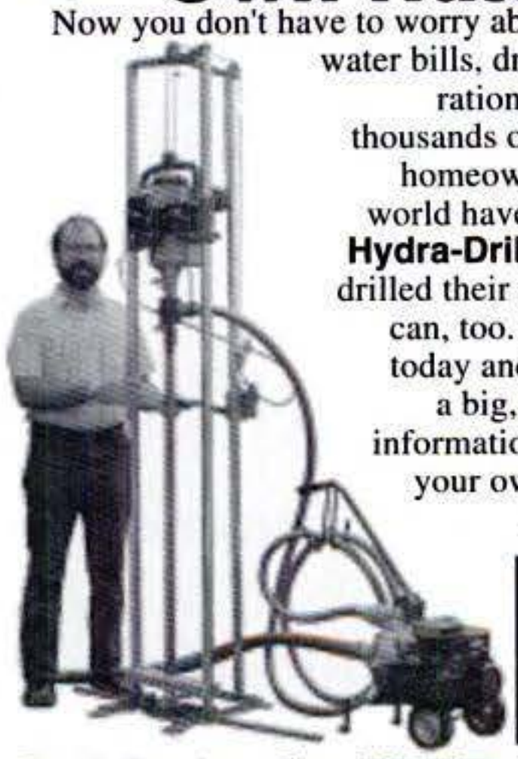

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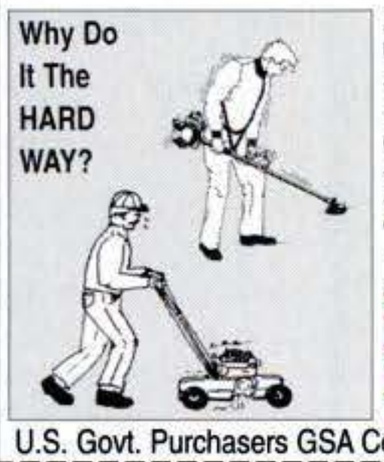

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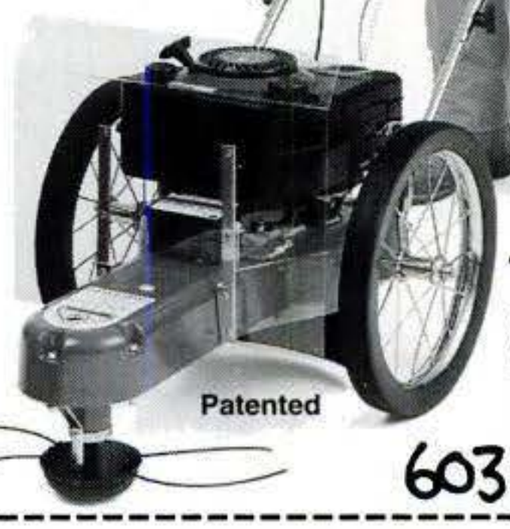

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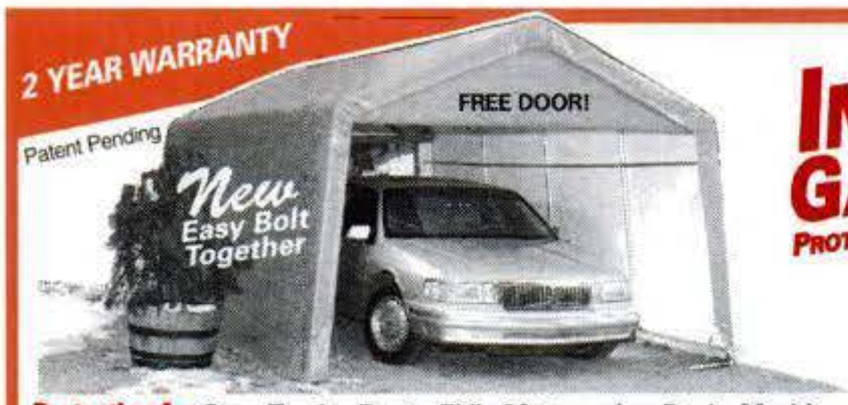

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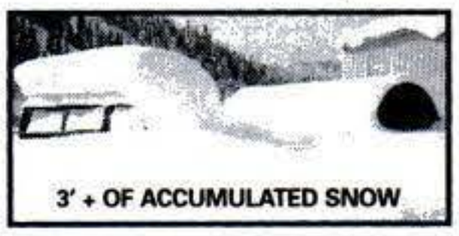

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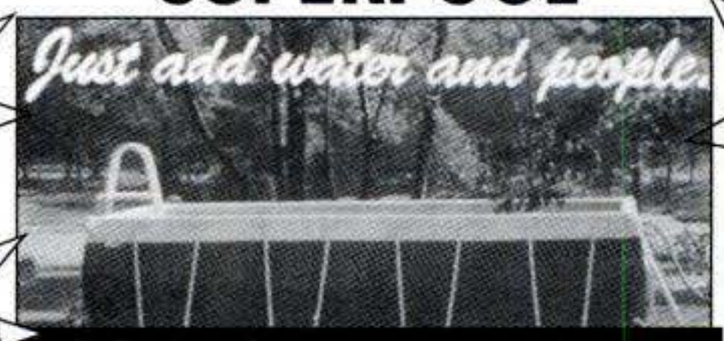

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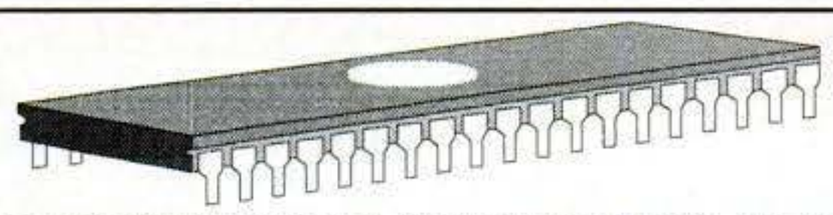

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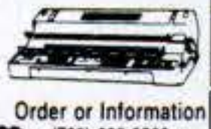

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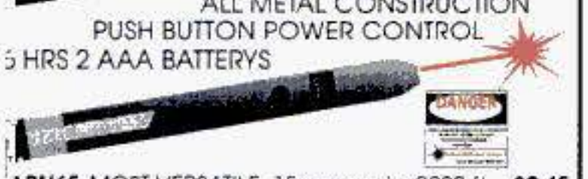

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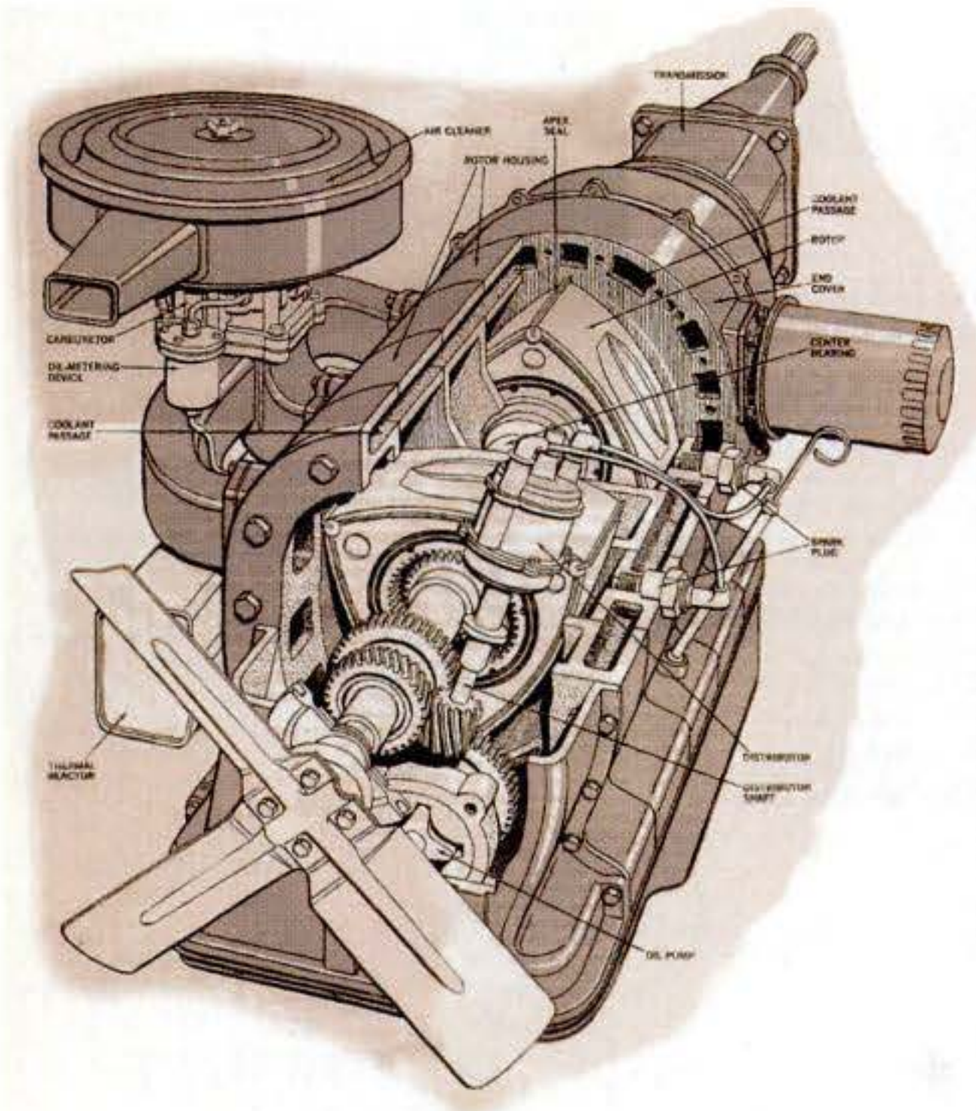

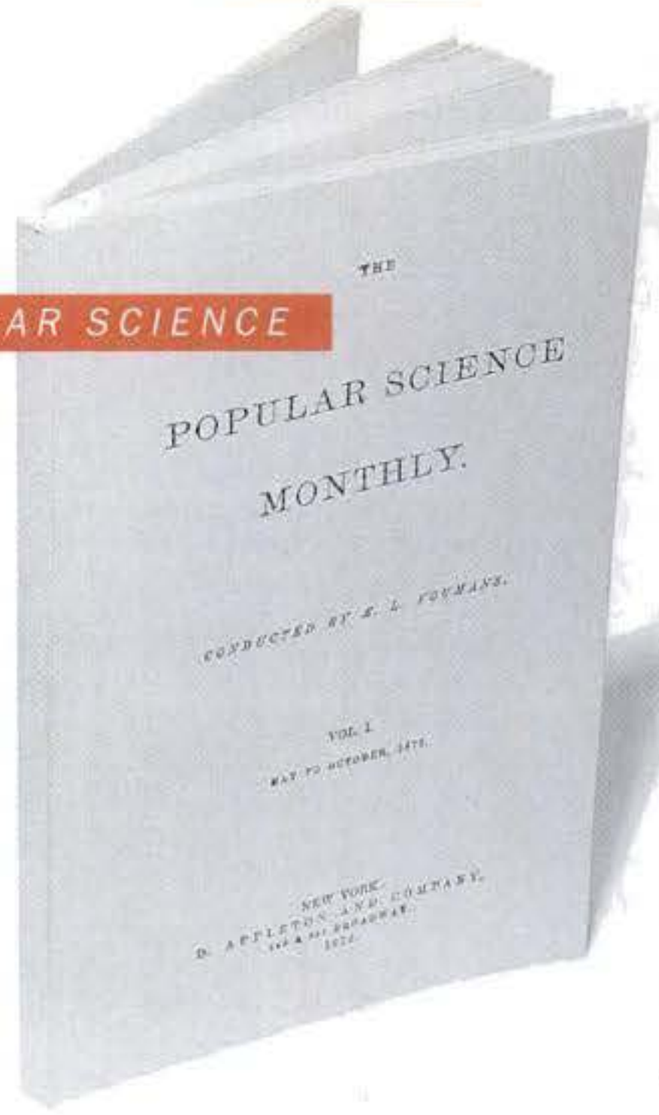

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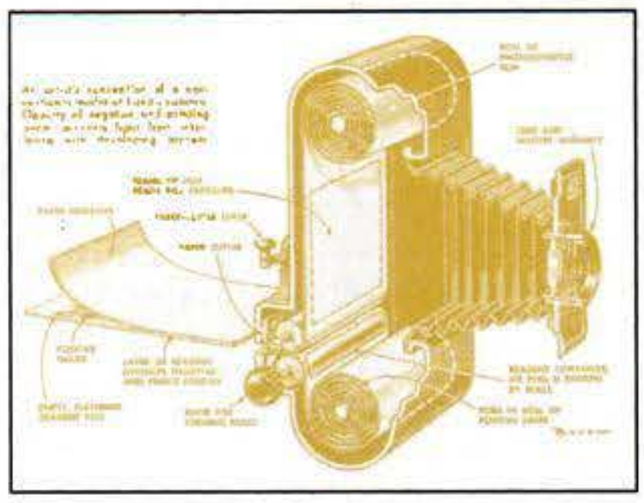
Seven thousand copies of POPULAR SCIENCE'S *inaugural issue were printed. By the end of the following year, circulation had risen to 12,000. Today, that figure stands at 1.55 million. Topics for the first issue included: "The Study of Sociology," "The Recent Eclipse of the Sun," and "Science and Immortality."*

Rotary Engine

25 YEARS AGO CHEVROLET WILL introduce its GM rotary engine as an option for the Chevy Vega—heralding the beginning of the end for the piston engine. The Wankel engine will cost between half and two-thirds of a piston engine of similar power. For that reason alone, the Wankel is bound to take over from the piston engine in future cars. Other advantages: light weight, small size, vibrationless running, low noise levels, wide speed range, as well as low-octane fuel capability.—*May 1972*

Plagued by poor fuel economy and high emissions, the Wankel engine never achieved the success predicted for it. The 1974 oil embargo prompted GM to cancel its plans to produce a Wankel rotary. Mazda, however, has continued development with considerable success. Today, the company's RX7 sports car is the only production car with a Wankel rotary engine—although it's now sold only in Japan.



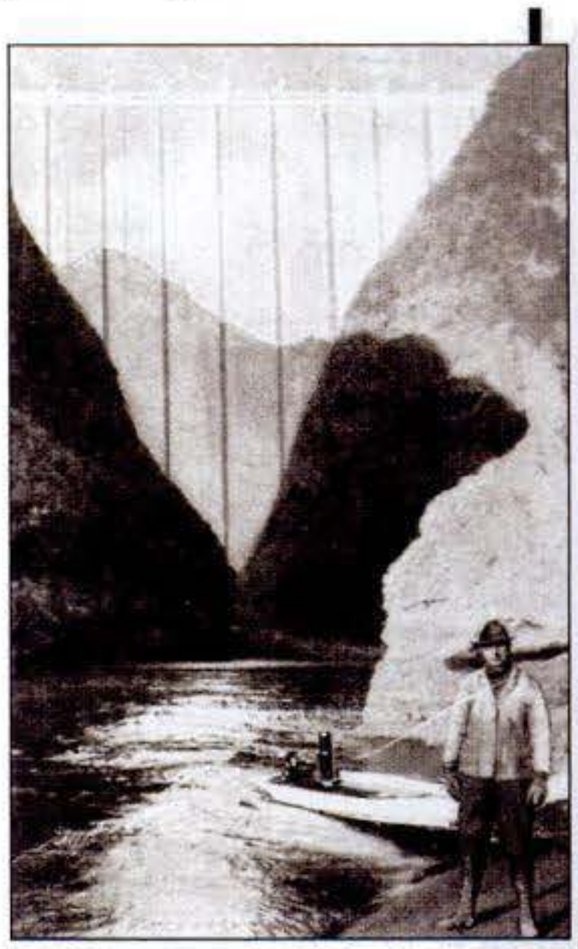
Do-Everything Camera

50 YEARS AGO EDWIN H. LAND, the 38-year-old president of the Polaroid Corp., has invented a one-step process in which the camera does everything. With his camera, you snap the shutter and turn a knob; 60 seconds later, you have a finished, dry print.—*May 1947*

Harnessing the Colorado

75 YEARS AGO HERE ON THE Nevada-Arizona border, the government proposes to construct a dam that will rise 735 feet above bedrock, creating a reservoir with a storage capacity of 31,000,000 acre-feet. The largest in the world, the dam (visualized at right) will back up the Colorado River for 80 miles.—*May 1922*

Begun in 1930 and completed in 1936 in Black Canyon, some 20 miles south of the original site, Boulder Dam was renamed in 1947 to honor President Herbert Hoover. Its reservoir, Lake Meade, still has the largest capacity of any U.S. reservoir.



Highway Construction

100 YEARS AGO THE NATION has begun to awaken to the importance of good roads. In some cases, communities themselves are taking the lead; in others, states show the way with financed programs. The theories of John Loudon McAdam, who constructed roads of compacted layers of small stones (hence, macadam), and Thomas Telford, who modified McAdam's system by substituting a foundation of irregular broken stone, are highly influential.—*May 1897*

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